United States Environmental Protection Agency
Region 2

DRAFT

NATIONAL REMEDY REVIEW BOARD BRIEFING PACKAGE AND CONTAMINATED SEDIMENT TECHNICAL ADVISORY GROUP CONSIDERATION MEMORANDUM

LOWER PASSAIC RIVER RESTORATION PROJECT

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LOWER PASSAIC RIVER RESTORATION PROJECT
DRAFT NRRB BRIEFING PACKAGE AND
CSTAG CONSIDERATION MEMORANDUM

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1.0 NRRB BRIEFING PACKAGE SUMMARY

1.1 SITE SUMMARY

1.1.1 Site Name and Location

The Lower Passaic River Restoration Project ("the Study") is a comprehensive study of the 17-mile tidal portion of the Passaic River and its approximately 118 square-mile watershed (hereinafter referred to as the Study Area) in northern New Jersey. The 17-mile tidal portion of the Lower Passaic River is considered an operable unit of the Diamond Alkali Superfund Site in Newark, New Jersey. During the course of the Study, sediments in the lower eight miles of the river were identified as a major source of contamination to the 17-mile Study Area and to Newark Bay. Based on a risk assessment and Focused Feasibility Study (FFS; Malcolm Pirnie, Inc., 2007b) conducted to evaluate remedial alternatives, the preferred remedy (the Source Control Early Action) will address these contaminated sediments in the lower eight miles of the Passaic River (hereinafter referred to as the Area of Focus). The Source Control Early Action, which will be a final action for the sediments in the lower eight miles, is intended to take place in the near term, while the comprehensive 17-mile Study is on-going.

1.1.2 Superfund Site Identification Number

The Superfund Site Identification Number for the Diamond Alkali Superfund Site is NJD980528996.

1.1.3 Operational History and Contaminants Present

The Lower Passaic River has a long history of industrialization. During the 1800s, the Lower Passaic River watershed was one of the major centers of the American industrial revolution, with early manufacturing, particularly cotton mills, developing in the area around Great Falls in Paterson. In subsequent years, many industrial operations developed along the banks of the Passaic River, including manufactured gas plants, paper manufacturing and recycling facilities, chemical manufacturing facilities, and others that used the river for wastewater disposal. Historical manufacturing operations and associated discharges from the Diamond Alkali Company along the banks of the Lower Passaic River in Newark resulted in the addition of the Diamond Alkali Superfund Site to the National Priority List (NPL) in the early 1980s. Direct and indirect discharges from various facilities have resulted in poor water quality, contaminated sediments, bans on fish and shellfish consumption, lost wetlands, and degraded habitat. Furthermore, the Lower Passaic River has received direct and indirect municipal discharges from the middle of the nineteenth century to the present time. Together, these waste streams (industrial and municipal) discharged many contaminants, including dioxins, petroleum hydrocarbons, polychlorinated biphenyls (PCB), pesticides, and metals to the Lower Passaic River, all of which adsorb to fine-grained sediments to varying degrees.

1.1.4 Key Features of the Site and the Surrounding Area

An important component of the region's historical development and urbanization was the deepening of the river to permit commercial navigation into the city of Newark and farther upriver. Several large dredging projects at the beginning of the twentieth century established and maintained a navigation channel through more than 15 miles of the river north of Newark Bay. Since the 1940s, there has been little maintenance dredging and none since the early 1980s. Consequently, the river has accumulated substantial "legacy" sediment deposits particularly in the lower eight miles, measuring up to 25 feet thick, at the same time that peak discharges of a number of contaminants that preferentially adsorb to solids were experienced prior to enactment of the Clean Water Act. Less sedimentation has occurred upstream because of the faster flowing narrower channel. Tidal mixing has distributed sediment contamination throughout the lower eight miles, as well as upriver and into Newark Bay and the New York – New Jersey Harbor Estuary.

Sediment contaminant concentrations are even greater in deeper sediments than at the surface. Sediment erosion due to the back-and-forth motion of the tides and storm events is most likely responsible for continuing releases of contaminants from the river bed. As a fraction of all of the solids sources to the Lower Passaic, resuspension of deeper sediments comprises about 10 percent of the total annual deposition. However, resuspension accounts for over 95 percent of the dioxin accumulating in the river bottom, and at least 40 percent of PCBs, pesticides, and mercury accumulating in the river.

The Lower Passaic River is also a major source of contaminants to Newark Bay. Sediment transport from the Lower Passaic River to Newark Bay delivers the contaminants found in Newark Bay's surficial sediments, particularly dioxin. It is estimated that the Lower Passaic River contributes approximately 10 percent of the average annual amount of sediment accumulating in Newark Bay, and more than 80 percent of the dioxin accumulating in the Bay. A recent study of dioxin contamination in New York Harbor (Chaky, 2003) provides a basis for tracing the Lower Passaic River dioxin signature through the entire Harbor. The Lower Passaic River also contributes approximately 20 percent of the mercury to Newark Bay.

Sediment contamination is not the only problem in the Lower Passaic River. The communities that line the banks of the Lower Passaic River are prone to flooding. Development of the banks and the watershed has eliminated vital wetlands and floodplains, so that flood events pose economic and public safety risks. Finally, the State of New Jersey has reaffirmed its need for the river's navigation infrastructure, as its communities develop plans for use of a restored river in the future. The State's needs are documented in this report and help define the reasonably anticipated future use for the Lower Passaic River (see Section 2.5.2.3 "Navigational Channel Depths to Accommodate Reasonably Anticipated Future Surface Water Uses").

1.1.5 On-Site and Surrounding Land Use

In general, the banks of the Lower Passaic River are highly developed with a combination of industrial, recreational, and residential land uses. The left bank (ascending) of the river between river mile (RM) 0.0 and RM4.6 (Newark, New Jersey) is fully industrially developed, and the right bank (ascending) in this region (Harrison, New Jersey) is occupied by the railroad tracks of the Port Authority Trans Hudson (PATH) system and an intermodal container handling facility. Upriver of RM4.6, the left bank is dominated by Joseph G. Minish Waterfront Park and McCarter Highway (New Jersey Route 21), which extends along the left bank, northward to Dundee Dam. The right bank in the area of RM4.6 is currently being redeveloped for a combination of residential and recreational uses. Continuing upriver to Dundee Dam, the right bank can be characterized as recreational parkland containing small public marinas and private docking facilities. Residential and light commercial areas are also present along the banks of the river. Current land use in the surrounding counties in New Jersey (*i.e.*, Bergen, Hudson, Essex, and Passaic Counties) consists of a combination of industrial, residential, and commercial uses.

1.1.6 Media and Primary Contaminants of Concern Addressed by the Preferred Remedy

The preferred remedy will address contamination in the river sediments in the Area of Focus. Contaminants of potential concern (COPCs) and contaminants of potential ecological concern (COPECs) as identified for the FFS (Malcolm Pirnie, Inc., 2007b) are listed in Table 1-1.

Table 1-1: COPCs and COPECs in the Sediments of the Lower Passaic River

Chemical Class	Chemical Name
Metals	Copper
	Lead
	Mercury
Polycyclic Aromatic Hydrocarbons (PAH)	Low Molecular Weight (LMW) [1]
	High Molecular Weight (HMW) [2]
PCBs	Total PCB [3]
	Toxic Equivalent Quotient (TEQ) for PCB
Pesticides	Total Chlordane
	Dieldrin
	Dichlorodiphenyldichloroethane (DDD) [4]
	Dichlorodiphenyldichloroethylene (DDE) [4]
	Dichlorodiphenyltrichloroethane (DDT) [4]
	Total DDT [4]
Polychlorinated dibenzodioxins/furans (PCDD/F)	2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD)
	TEQ for PCDD/F

[1] LMW PAH is defined as the sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene with samples flagged as not detected incorporated into the summation as zero.
[2] HMW PAH is defined as the sum of benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, indeno[1,2,3-c,d]pyrene, and pyrene with samples flagged as not detected incorporated into the summation as zero. Total PAH is the sum of HMW PAH and LMW PAH.
[3] Total PCB is defined as the sum of 209 PCB congeners with samples flagged as not detected incorporated into the summation as zero.
[4] DDD, DDE, and DDT refers only to the 4,4'-isomers. Total DDT is defined as the sum of DDD, DDE, and DDT.

1.1.7 Operable Units Addressed by the Preferred Remedy and the Media Addressed by Each Operable Unit

Operable Unit (OU) 2 of the Diamond Alkali Superfund Site consists of the 17-mile stretch of the Lower Passaic River. The preferred remedy will address the entire Area of Focus evaluated for the FFS, defined as the contaminated fine-grained sediments in the lower eight miles of the Passaic River. Therefore, the preferred remedy will address a portion of OU2. The Source Control Early Action, which will be a final action for the sediments in the lower eight miles, is intended to take place in the near term, while the comprehensive 17-mile Study is on-going.

1.2 RISK SUMMARY

Extremely contaminated surface sediments present high levels of risk to human heath and the ecosystem. A risk assessment conducted for the Lower Passaic River (Appendix C of the FFS; Malcolm Pirnie, Inc., 2007b) concluded that among adults consuming 40 meals per year of fish from the Lower Passaic River over 30 years, their risk of developing cancer would be one in one hundred. This risk is greater than the United States Environmental Protection Agency's (USEPA) risk range established in the Superfund Program of one in ten thousand to one in a million. Approximately 65 percent of the human health cancer risk is associated with the presence of dioxin. Most of the remaining cancer risk (approximately 33 percent) is from PCB, while all other contaminants combined contribute approximately two percent. Accordingly, fish consumption advisories have been in place for many years due to contamination from dioxins and PCB. Similar risks are present for wildlife, although metals and pesticides cause most of the risk to fish, while dioxin and PCB cause most of the risks for animals and birds that eat fish.

1.3 REMEDIATION GOALS

Remedial Action Objectives (RAOs) were established to describe what the cleanup is expected to accomplish, and preliminary remediation goals (PRGs) were developed as targets for the cleanup to meet in order to protect human health and the environment.

The RAOs were developed by the USEPA with input from the partner agencies regarding current and reasonably anticipated future uses of the site. The RAOs are as follows:

- Reduce cancer risks and non-cancer health hazards for people eating fish and shellfish from the Lower Passaic River by reducing the concentration of COPCs in fish and shellfish.

- Reduce the risks to ecological receptors by reducing the concentration of COPECs in fish and shellfish.

- Reduce the mass of COPCs and COPECs in sediments that are or may become bioavailable.

- Remediate the most significant mass of contaminated sediments that may be mobile (*e.g.*, erosional or unstable sediments) to prevent it from acting as a source of contaminants to the Lower Passaic River or to Newark Bay and the New York-New Jersey Harbor Estuary.

Applicable or relevant and appropriate requirements (ARARs), human health and ecological risk-based concentrations (RBCs), and background concentrations were evaluated in the selection of PRGs. The background concentrations derived from recent sediment data from above Dundee Dam were found to be above the risk-based thresholds. Since the Superfund program, generally, does not clean up to concentrations below natural or anthropogenic background levels (USEPA, 2002c), background concentrations from sediment above Dundee Dam were selected as PRGs. Table 1-2 lists the background concentrations of COPECs and COPCs, selected as the PRGs.

Table 1-2: Selected PRGs

Contaminant	Background Concentration (ng/g)
Copper	80,000
Lead	140,000
Mercury [1]	720
Low Molecular Weight PAHs	8,900
High Molecular Weight PAHs	65,000
Total PCB	660
Sum of DDD, DDE, and DDT isomers (Total DDx)	91
Dieldrin	4.3
Chlordane	92
2,3,7,8-TCDD	0.002

[1] All occurrences of mercury are assumed to be methylated for purposes of this evaluation.

The COPC and COPEC concentrations known to exist in the surface sediments of the lower 8 miles are much greater than these PRGs. For this reason a remedial strategy that can reduce the concentrations to at least the level of background is necessary to begin to achieve the RAOs.

The background levels for many of the contaminants pose unacceptable risks, in part resulting from continuing contributions from upstream sources. Thus, while the Source Control Early Action addresses the contaminated sediments of the lower eight miles of the Passaic River, a separate source control action will need to be implemented above Dundee Dam to identify and reduce or eliminate those background sources.

1.4 DESCRIPTION OF REMEDIAL ALTERNATIVES

A description of the six active remedial alternatives for the Lower Passaic River Restoration Project is presented in Table 1-3. The remedial alternatives and cost estimates were developed as part of the FFS (Malcolm Pirnie, Inc., 2007b).

The six active remedial alternatives are equivalent in risk reduction and the estimated time to achieve preliminary remediation goals. Based on the prediction of future surface sediment concentrations generated in the Empirical Mass Balance Model (EMBM) (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b), active remediation of the Area of Focus followed by monitored natural recovery (MNR) will achieve any threshold for 2,3,7,8-TCDD, which is responsible for about 65 percent of the risk, 40 years faster than it would be achieved by MNR alone. The reduction of other COPCs and COPECs is also accelerated by active remediation of the Area of Focus.

Table 1-3: Description of Active Remedial Alternatives

Alternative	Navigation Usage and Navigation Channel Depths [1]	Flooding [2] (additional flooding)	Dredging Volume (millions of cubic yards)	Construction Time	Human Health Risk Assessment [3] (Fish Consumption) [4]	Ecological Risk Assessment [3] (Heron) [5]	DMM Scenario	Total Present Worth Costs
Alternative 1: Removal of Fine-Grained Sediment from Area of Focus	Authorized channel dimensions accommodated (see Alternative 3 below)	Decrease (not estimated)	11.0	12 years	5×10^{-4} (95 percent reduction compared to current)	2	A [6]	$1,947,000,000
							B [7]	$2,272,000,000
Alternative 2: Engineered Capping of Area of Focus	Navigation significantly reduced	Considerable Increase (93 acres)	1.1	6 years			A	$863,000,000
							B	$1,111,000,000
Alternative 3: Engineered Capping of Area of Focus Following Remediation of Federally Authorized Navigation Channel	Authorized channel dimensions accommodated • 30 feet from RM0 to RM2.5 • 20 feet from RM2.5 to RM4.6 • 16 feet from RM4.6 to RM8.1 • 10 feet above RM8.1	Decrease (not estimated)	7.0	8 years			A	$1,518,000,000
							B	$1,845,000,000
Alternative 4: Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Current Usage	Current navigation usage accommodated • 30 feet from RM0 to RM1.2 • 16 feet from RM1.2 to RM2.5 • Navigation above RM2.5 significantly reduced	Considerable Increase (24 acres)	4.4	6 years			A	$1,267,000,000
							B	$1,596,000,000
Alternative 5: Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Future Usage	Anticipated future navigation usage accommodated • 30 feet from RM0 to RM1.2 • 16 feet from RM1.2 to RM3.6 • 10 feet above RM3.6	Decrease (-17 acres)	6.1	7 years			A	$1,421,000,000
							B	$1,749,000,000
Alternative 6: Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Future Usage and Removal of Fine-Grained Sediment from Primary Inventory Zone and Primary Erosional Zone		Decrease (not estimated)	7.0	8 years			A	$1,496,000,000
							B	$1,824,000,000

DMM: Dredged Material Management

1 Navigation channel depths are provided in feet below mean low water.

2 Flood estimates are provided for the 100-year return interval river flow event.

3 Risk reductions presented are for a 30-year timeframe. Alternatives 1 though 6 rely on MNR with institutional controls in place to achieve 1×10^{-4} and Hazard Index = 1 in subsequent years. In addition, separate source control actions above Dundee Dam, when implemented, will accelerate the time frame to reach 1×10^{-4} and Hazard Index = 1.

4 A human health risk assessment was also conducted for the scenario of crab consumption. Refer to Appendix C of the FFS (Malcolm Pirnie, Inc., 2007b) for additional information.

5 An ecological risk assessment was also conducted for other species. Refer to Appendix C of the FFS (Malcolm Pirnie, Inc., 2007b) for additional information.

6 DMM Scenario A: Nearshore Confined Disposal (see Section 2.8 “Description of Remedial Alternatives”)

7 DMM Scenario B: Nearshore Confined Disposal, Storage, Thermal Treatment, and Beneficial Use of the Treated Material (see Section 2.8 “Description of Remedial Alternatives”)

1.5 PREFERRED REMEDIAL ALTERNATIVE

Not addressed.

1.6 STAKEHOLDER VIEWS

1.6.1 State's Position on the Preferred Remedy

USEPA will offer a position on the preferred remedy after the Briefing Package and other project documents have been reviewed by the National Remedy Review Board (NRRB) and USEPA's Office of Superfund Remediation and Technology Innovation (OSRTI) Sediment Team.

State acceptance is not addressed in this document, but will be addressed in the Record of Decision (ROD). It is important to note that the New Jersey Department of Transportation (NJDOT) is the Water Resources Development Act (WRDA) non-federal sponsor and the New Jersey Department of Environmental Protection (NJDEP) is a Trustee for the site; both are agency partners participating in the Study. As such, input from the State of New Jersey was sought and considered throughout the development of the FFS. In addition, the NJDOT developed a memorandum outlining the State's recommendations for the depth of the navigation channel to accommodate future use; this memorandum guided the development of some of the remedial alternatives for the Lower Passaic River.

1.6.2 Major Stakeholders' Position on the Preferred Remedy

Community acceptance of the preferred remedy will be assessed in the ROD once public comments received on the FFS and proposed plan have been received. Input from the public and interested stakeholders, including the partner agencies, was sought and considered throughout the development of the FFS. This occurred through various technical workgroup sessions organized and hosted by the USEPA, through publication of information on the project website (www.ourPassaic.org), publication of information to interested members of the public in the form of ListServ notices, and other community involvement activities. A municipalities workshop was held in April 2007 to share project information and address community-specific concerns. Municipalities that participated in the workshop include Bayonne, Bloomfield, Clifton, Elizabeth, Garfield, Harrison, Newark, Nutley, and Rutherford.

2.0 NRRB BRIEFING PACKAGE

2.1 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The Lower Passaic River Restoration Project ("the Study") is a comprehensive study of the 17-mile tidal portion of the Passaic River and its watershed in northern New Jersey. This integrated Study is being implemented by the USEPA under the Superfund Program (the Lower Passaic River is a part of the Diamond Alkali Superfund Site); by the United States Army Corps of Engineers (USACE) and NJDOT under WRDA; and by the United States Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), and NJDEP as Natural Resource Trustees. The scope of the Study is to gather data needed to make decisions on remediating contamination in the river to reduce human health and ecological risks, improve the water quality of the river, improve and create aquatic habitat, improve human use, and reduce contaminant loading in the Lower Passaic River and the New York-New Jersey Harbor Estuary.

The Study Area (118 square miles) is defined as the Lower Passaic River and its basin, which comprises the tidally-influenced portion of the river from the Dundee Dam (RM17) to Newark Bay (RM0), and the watershed of this river portion downstream of the dam, including tributaries such as the Saddle River, Second River, and Third River (Figure 2-1). Note that two systems exist for identifying locations in the Lower Passaic River (Figure 2-2). The system used in this document to identify locations along the river is based on the centerline of the USACE navigation channel. However, data evaluations for the Lower Passaic River use a slightly (about ¼ mile) different river mile system, which is referred to in this document as the "Remedial Investigation/Feasibility Study (RI/FS) system." The RI/FS system uses a centerline that is equidistant from each shore and independent of the federally authorized navigation channel. River mile locations in this document are provided using the USACE system, except where noted.

During the course of the Study, sediments in the lower eight miles of the river were identified as a major source of contamination to the 17-mile Study Area and to Newark Bay. An FFS (Malcolm Pirnie, Inc., 2007b) was undertaken to evaluate a range of remedial alternatives that might be implemented as an early action to control that major source. The Source Control Early Action will address contaminated sediments in the lower eight miles of the Passaic River (hereinafter referred to as the Area of Focus; Figure 2-2), in order to more rapidly reduce risks to human health and the environment. The Source Control Early Action, which will be a final action for the sediments in the lower eight miles, is intended to take place in the near term, while the comprehensive 17-mile Study is on-going.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Lower Passaic River has a long history of industrialization. During the 1800s, the areas surrounding the Lower Passaic River became a focal point for our nation's industrial revolution. By the 20th century, Newark had established itself as the largest industrial-based city in the country. The urban and industrial development surrounding the Lower Passaic River, combined with associated population growth, have resulted in poor water quality, contaminated sediments, bans on fish and shellfish consumption, lost wetlands, and degraded habitat. Table 2-1 contains a history of events surrounding the Diamond Alkali Superfund Site and creation of the Study. While this chronology of events is significant to the project, the Diamond Alkali site is not the only source of contamination in the Lower Passaic River. It is important to understand that sediment contamination in the Lower Passaic River, and other problems being addressed by the partner agencies, came from numerous parties and sources over the past 100 years or more, including direct discharges via spills, runoff, groundwater migration and outfall pipes, as well as indirect discharges through sewers, to name a few. Population growth and development pressures have also contributed to the degradation of the Lower Passaic River.

Table 2-1: Project History (modified from Malcolm Pirnie, Inc., 2006a)

Date	Activity
1940s	Manufacturing facility located at 80 Lister Avenue, Newark, New Jersey, begins producing DDT and phenoxy herbicides.
1951-69	Diamond Alkali Company (subsequently known as the Diamond Shamrock Chemicals Company) owns and operates a pesticides manufacturing facility at 80 Lister Avenue. In 1960, an explosion destroys several plant processes; also in 1960, production limited to herbicides, including those used in the formulation of the defoliant "Agent Orange." Diamond Alkali Company ceases operations in 1969.
1970-83	80 Lister Avenue goes through a series of new ownerships and production processes.
1976	Congress authorizes the USACE to begin flood control study for the Passaic River Basin under WRDA.
1982	NJDEP releases fishing advisories for reduced consumption of white perch and white catfish in the Passaic River. River abutting 80 Lister Avenue closed for commercial fishing of American eel and striped bass.
1983	NJDEP and USEPA collect samples; high levels of dioxin detected in the Passaic River and at 80 Lister Avenue property. Diamond Alkali site proposed by USEPA to the Superfund NPL. Fish advisories begin for the Passaic River.
1984	NJDEP issues Administrative Consent Order to Diamond Shamrock Chemicals Company to perform investigation of 80 Lister Avenue. Site finalized on the Superfund NPL. Site investigation of 80 Lister Avenue begins. NJDEP issues Administrative Consent Order to Diamond Shamrock Chemicals Company to perform cleanup of select dioxin-contaminated properties and to perform investigation of 120 Lister Avenue.
1985	Investigation results released to public. Cleanup options for 80 and 120 Lister Avenue properties detailed in feasibility study.
1986	NJDEP presents cleanup options to public.
1987	USEPA and NJDEP hold public meeting to discuss the Proposed Plan for cleanup. USEPA selects interim cleanup plan (Record of Decision) for the 80 and 120 Lister Avenue portion of the Diamond Alkali Superfund Site, requiring the containment of contaminated materials.
1988	Diamond Alkali Superfund Site transferred from state lead under NJDEP to federal lead under USEPA.

Date	Activity
1990	The federal court approves a Consent Decree among Occidental Chemical Corporation, as successor to Diamond Shamrock Chemicals Company, and Chemical Land Holdings, Inc. (now known as Tierra Solutions, Inc.) and USEPA and NJDEP to implement the 1987 interim cleanup plan. USACE receives Congressional WRDA authorization for Joseph G. Minish Passaic Waterfront Park and Historic Area flood control study as an element of the Passaic River Flood Damage Reduction Project.
1993	USEPA forms team to study lower six-mile stretch of the Passaic River.
1994	USEPA posts trilingual fishing advisory signs along the banks of the Passaic River near the Diamond Alkali site. USEPA and Occidental Chemical Corporation sign an Administrative Order on Consent to investigate the lower six-mile stretch of the Passaic River. Demolition of buildings at 80 Lister Avenue is completed.
1995	Field work begins on the lower six-mile stretch of the Passaic River.
1996-99	USEPA, at the request of the local community, explores the potential for implementing an alternative to the interim cleanup plan selected in 1987. Alternative plan not found. USEPA reviews and approves design of 1987 interim cleanup plan.
1999	Congress authorizes the Hudson-Raritan Estuary Study, and the Passaic River is added as a priority site under WRDA "section 312 environmental dredging."
2000	Congress authorizes the USACE to conduct the Lower Passaic River Ecosystem Restoration Study under WRDA.
2000	USACE initiates a Reconnaissance Study for the Lower Passaic River. Interim cleanup begins at land portion of Diamond Alkali site, which included installation of a cap, slurry wall, and flood wall around the properties and groundwater pumping and treatment.
2001	Interim cleanup completed at land portion of Diamond Alkali site. USACE completes Reconnaissance Study for the Lower Passaic River.
2002	Urban Rivers Restoration Initiative launched; USEPA and USACE sign National Memorandum of Understanding for the purpose of coordinating the planning and execution of urban river cleanup and restoration.
2003	Six-mile study of Lower Passaic River expanded to include the extent of contamination in the lower 17 miles of the Passaic River. State and federal trustees sign a Memorandum of Agreement for Natural Resource Damage Assessment and Restoration for the Diamond Alkali Superfund Site and environs. USEPA, USACE, and NJDOT sign a Project Management Plan for the Lower Passaic River Restoration Project. Feasibility cost sharing agreement signed by USACE and NJDOT. Selection of Passaic River as one of eight national pilot projects of the Urban Rivers Restoration Initiative.

Date	Activity
2004	USEPA enters into an Administrative Order on Consent with 31 Potentially Responsible Parties (PRPs) to fund Superfund portion of the Lower Passaic River Restoration Project.
2005	Twelve additional PRPs were added to the Administrative Order on Consent for the Superfund portion of the Lower Passaic River Restoration Project.

The legal history of the Lower Passaic River Restoration Project extends back to 1994, during which the USEPA and Tierra Solutions, Inc. (TSI) signed an Administrative Order of Consent (AOC) to investigate dioxin in a six-mile stretch of the Lower Passaic River. At this time, TSI was the sole PRP and dioxin was the sole COPC. The six-mile stretch was termed the Passaic River Study Area (PRSA). As a result of the sediment sampling conducted by TSI under this AOC, the USEPA decided to expand the investigation to the entire 17 miles of the Lower Passaic River and to expand the COPCs to a larger suite of chemicals. This expansion marked the end of the six-mile PRSA. On June 22, 2004, the USEPA and 31 PRPs signed an AOC for the PRPs to fund USEPA's work on the 17-mile study area, and the COPC list was expanded further. This AOC was applicable to the study phase only and did not address the implementation of a remedial action. In February 2004, the USEPA and TSI signed an AOC to investigate Newark Bay. TSI was the sole PRP in this AOC. The AOC stipulated that while the USEPA would ensure that the Newark Bay and Lower Passaic River studies are conducted in coordination with each other, the studies would remain separate with respect to administration and funding.

2.3 SCOPE AND ROLE OF RESPONSE ACTION

The Lower Passaic River Restoration Project addresses OU2, one of three operable units of the Diamond Alkali Superfund Site which have been established due to the significantly different hydro-geographic and contaminant characteristics in various affected areas. The upland area encompassing the manufacturing facility originally named as the Diamond Alkali Superfund Site (located at 80 and 120 Lister Avenue in Newark, New Jersey) is considered OU1. OU2 originally consisted of the six-mile

PSRA, but it has since been expanded to include the entire 17-mile stretch of the Lower Passaic River between Newark Bay and the Dundee Dam. Newark Bay and portions of the Hackensack River, the Arthur Kill, and the Kill van Kull comprise OU3.

As noted above, sediments in the lower eight miles of the river, a portion of OU2, have been identified as a major source of contamination to the 17-mile Study Area and to Newark Bay, and an FFS has been undertaken to evaluate a range of remedial alternatives for an early action to control that major source. The Source Control Early Action will address contaminated sediments in the lower eight miles of the Passaic River (the Area of Focus), in order to more rapidly reduce risks to human health and the environment. Sediments in the Area of Focus consist of the predominantly fine-grained, contaminated sediment present in the Brackish and Transitional Sections[1] of the Lower Passaic River. Geomorphological data suggest fine-grained sediments exist in a contiguous stretch up to approximately RM8. While the preponderance of available contaminant data represents the area between RM1 and RM7, the Conceptual Site Model (CSM) (Malcolm Pirnie, Inc., 2007a) suggests that RM0 to RM1 and RM7 to RM8 will behave similarly to the area between RM1 and RM7. The Source Control Early Action, which will be a final remedial action for the sediments in the lower eight miles, is intended to take place in the near term, while the comprehensive 17-mile Study is on-going.

Components of the early action include the following:

- Pre-Design Investigation: The purpose of the pre-design investigation will be to provide current data on sediment conditions prior to initiation of remedial design. The pre-design investigation program will involve sediment sampling for

[1] As described in the Conceptual Site Model (Malcolm Pirnie, Inc., 2007a), the Lower Passaic River may be divided into three sections: a Freshwater section dominated by freshwater flow entering over Dundee Dam, a Brackish section dominated by saline waters from Newark Bay, and a Transitional section where the two mix.

chemical and geotechnical parameters, collection of geophysical data, a video survey to identify debris in the target area, and cultural resource surveys to identify any historically significant items present in the sediment.

- Permitting, Design, and Contractor Work Plans: Permitting for an early action will begin during the pre-design investigation phase, and will be completed prior to the start of construction. Upon completion of the pre-design work, a final design incorporating specifications and drawings will be prepared, and a contractor will be selected to perform the construction work. The contractor will be required to prepare its work plans detailing operational parameters for equipment to be used, quality assurance and quality control procedures, safety procedures, work schedules, and other items, as required.

- Mobilization/Demobilization and Annual Shutdown/Startup: After completion of pre-construction activities, the contractor will mobilize required equipment to the site. Demobilization involves removing all equipment from the staging and work areas and meeting any requirements for decontamination of verification of acceptable status of the processing areas. Annual shutdown/startup of construction operations may be required if extended periods of seasonal or weather-related downtime are encountered.

- Debris Management: Prior to implementing any remedial activity, it will be necessary to remove large debris from the sediment surface to facilitate subsequent construction operations. A video survey will be performed during the pre-design investigation to refine current debris quantity estimates, which are based on a side-scan sonar survey performed by Aqua Survey, Inc. in 2004.

- Dredging: Remedial alternatives involving dredging will utilize a mechanical dredge fitted with an environmental clamshell bucket. Major feasibility considerations for mechanical dredging include potential productivity rates that may be achieved, the accuracy of the environmental dredging process, methods for minimizing resuspension during dredging, residuals management, and dredged material management.

- Capping: Significant quantities of cap material will be required for alternatives involving sediment containment. Major feasibility considerations associated with capping activities include determining a source of cap material, the equipment that will be used for cap placement, requirements for cap thickness, the incorporation of an armor layer to minimize cap erosion, and the potential for navigation and flooding impacts resulting from cap placement.

- Dredged Sediments Transport to a Processing Facility: The characteristics of a suitable sediment processing location include adequate river frontage for supporting barge operations, sufficient land for materials processing and storage, and access to rail facilities. Scows will deliver the dredged material to the processing facility via conventional methods such as a crane or excavator. Prior to unloading the scows, excess water will be pumped off, treated, and discharged. Once the dredged material has been off-loaded, it will be processed to improve its handling and shipping characteristics.

- Construction Monitoring Program: During the construction period, water quality in the vicinity of construction operations will be monitored. Confirmatory sampling to verify placement of backfill or capping material will be implemented to document a sufficient thickness of material and characterize contaminant distribution at and around the interface between the existing sediment and cap material. The depth of sediment removed as well as the depth of backfill or capping material placed will also be monitored. In addition, ecological monitoring will be performed during the course of construction to assess the impact on the biological community within the Area of Focus, as well as upriver and downriver of this area.

- Post-Construction Monitoring Program: A post-construction monitoring program will be performed for each alternative for a period of thirty years. The purpose of the post-construction monitoring program will be to document the performance of the selected remedial measures in reducing COPC and COPEC concentrations in the water, sediment, and biota associated with the Lower Passaic River. Changes in the installed fill and capping material will be monitored at least annually to identify areas undergoing scour or deposition. In addition, sediment profile imaging will be performed to monitor habitat recolonization. This program will be continued for as long as necessary to document the achievement of RAOs; costs have been estimated for this activity for a period of thirty years.

- Restoration: The implementation of a remedial alternative in the Area of Focus will impact existing habitat conditions. As part of the reconstruction of the remediated area, substrate will be placed that is suitable for future activities relating to habitat restoration. (The scope does not include habitat restoration.) In addition, existing mudflats will be reconstructed in select small areas of the river. Reconstruction will involve the removal of four feet of contaminated sediment and the placement of two feet of sand as substrate and two feet of mudflat reconstruction material.

2.4 SITE CHARACTERISTICS

A CSM[2] for the Study was initially presented in the August 2005 version of the Work Plan (Malcolm Pirnie, Inc., 2005c). This CSM has been updated as part of the FFS (Appendix A of the FFS; Malcolm Pirnie, Inc., 2007b). A summary of conclusions discussed in the CSM is presented below.

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[2] A CSM expresses a site-specific contamination problem through a series of diagrams, figures, and narrative consistent with USEPA Office of Solid Waste and Emergency Response (OSWER) remedial investigation and feasibility study guidance (USEPA, 1988).

2.4.1 Site Overview

The Lower Passaic River is a partially stratified estuary where the degree of stratification and the location of the salt front at any point in time reflect a dynamic balance between the freshwater flow and the tidal exchange with Newark Bay. Tidal displacement in the Lower Passaic River is quite large, with the salt front moving several miles during each tidal cycle. The Lower Passaic River carries a large suspended solids load derived from upstream sources and Newark Bay, as well as mobilization of previously deposited solids due to tidal displacement.

The Lower Passaic River was one of the major centers of the American industrial revolution, with early manufacturing, particularly cotton mills, developing in the area around the Great Falls in Paterson, New Jersey. In subsequent years, a multitude of industrial operations developed along the banks of the Passaic River, as the cities of Newark and Paterson grew. These industrial operations included manufactured gas plants, paper manufacturing and recycling facilities, chemical manufacturing facilities, and others that used the river for wastewater disposal. Moreover, the Lower Passaic River has been used as a major means of conveyance for municipal sewage and storm water discharges from the middle of the nineteenth century to the present time. Ultimately, many contaminants were discharged to the Lower Passaic River, including 2,3,7,8-TCDD, PAHs, PCBs, pesticides such as DDT, and heavy metals such as mercury and lead.

An important component of the region's development and urbanization was the deepening of the river to permit commercial vessels to travel to the city of Newark and farther upriver. Several large dredging projects were undertaken at the beginning of the twentieth century to create a navigation channel to approximately RM15. Since the 1940s, there has been little maintenance dredging above RM2. Consequently, extensive fine grained sediment deposits exist in the channel, particularly between RM2.5 and RM8. The coincidence of contaminant discharges to the river and a significant suspended sediment load created an ideal situation for accumulating contaminated sediments. As a result, the river accumulated substantial sediment beds, measuring up to 25 feet thick in some areas. These thick sediment deposits remain, primarily below RM8 where the relatively wider river channel provided favorable conditions for rapid sediment accumulation. Relatively little accumulation has occurred upstream of RM8 because of the narrower channel conditions. The change in river geometry is illustrated in Figure 2-3), which shows the relationship between location and the river's cross sectional area.

Despite the prevalence of thick sediment deposits below RM8, the sediments in this region are not all stable, and erosional areas have been identified throughout the lower 8 miles of the river. These erosional areas are believed to be responsible for on-going releases of contaminant-bearing solids from the legacy sediments on the river bed. This is shown in Figure 2-4, which plots the fractions of depositional and erosional areas as a function of location (river mile), calculated for quarter-mile increments. A detailed examination of sediment deposition rates between RM1 and RM7 indicates a high degree of spatial heterogeneity, with local rates varying from about 6 inches/year of net erosion to about 8 inches/year of net deposition. Historical deposition rates were probably higher than current rates (and erosional areas fewer and smaller) because of the more extensive salt front intrusion and deeper channel depths immediately after the initial channel dredging, which would have enhanced settling of suspended sediment.

A comparison of current and historical mass balances of solids coming into the Lower Passaic River shows that the relative importance of the solids load coming from the head-of-tide has increased over the years, compared to that coming from Newark Bay. The current head-of-tide solids load to the Lower Passaic River is greater than the annual average rate of accumulation in the river; however, the historical rates of sediment accumulation in the Lower Passaic River were probably too large to be sustained solely by the Passaic's head-of-tide solids loads, suggesting that solids transport from Newark Bay may have supplied the additional solids.

2.4.2 Site Geology

The Lower Passaic River is situated within the Newark Basin portion of the Piedmont physiographic province, located between the Atlantic Coastal Plain Province and the Appalachian Plateau (Fenneman, 1938). The Newark Basin is underlain primarily by sedimentary rocks (sandstone, shale, calcareous shale, and conglomerate), to a lesser extent by igneous rocks (basalt and diabase), and may locally be underlain by metamorphic rocks (slate and schist). The Newark Basin rocks are from the mid-Triassic to early Jurassic periods. Bedrock underlying the Lower Passaic River is the Passaic Formation (Olsen *et al.*, 1984; Nichols, 1968), consisting of interbedded red-brown sandstone and shale.

Almost the entire Passaic River Basin, including the Lower Passaic River, was subjected to glacial erosion and deposition as a result of the last Wisconsin glaciation stage. Considerable quantities of stratified sand, silt, gravel, and clay were deposited throughout the area. These glaciofluvial deposits, in the form of glacial lake sediments, overlie bedrock and underlie the Meadowlands section of Newark Basin.

Sediment sampling programs conducted in the Lower Passaic River have typically encountered deposits of silt overlying sequences of sand and, in some cases, red-brown clay. The thickness of the silt deposit in a given location has been shown to correlate well with the depth of the constructed navigation channel at that location, suggesting that the navigation channel was constructed by dredging into the sand sequence.

2.4.3 Surface Water Hydrology

The Lower Passaic River and the Hudson-Raritan Estuary are a unique hydrologic system that encompasses a major metropolitan area in the United States, which includes two major cities: New York City, New York and Newark, New Jersey. Since the American industrial revolution, this area has experienced significant urbanization and industrial development, which has consequently impacted the surrounding ecosystems and waterways. Accidental and intentional discharges of industrial waste and municipal sewage have degraded sediment and water quality in the estuary. As contaminated solids and water enter the system, they are diluted and are disseminated throughout the estuary by the incoming and outgoing tides. These tides cause twice-daily mixing of surficial sediments through the resuspension and redeposition of solids. Over time, solids that originated from one end of the estuary (*e.g.*, the Lower Passaic River) are transported to other regions of the estuary (*e.g.*, the Hudson River). Understanding how the estuary operates (*i.e.*, how the Lower Passaic River connects to the estuary and how contaminated solids are transported through the system) is an important tool in discerning how to effectively remediate and restore the Lower Passaic River.

2.4.3.1 The Hudson-Raritan Estuary

The Hudson-Raritan Estuary encompasses an area of over 42,000 square kilometers, making it one of the largest estuaries on the east coast of the United States. The estuary encompasses several major water bodies, such as the Hudson River, Raritan River, Upper and Lower New York Bay, as well as Newark Bay and its tributaries, including the Lower Passaic River (Figure 2-5). The Hudson River flows south through New York State and into Upper New York Bay, which is located between Manhattan Island and New Jersey. Lower New York Bay is bounded on the north by Staten Island and Brooklyn, New York and on the south by New Jersey. New York Bay connects to the New York Bight and the Atlantic Ocean between Sandy Hook, New Jersey and Rockaway Point, New York. Historically, Lower New York Bay has been the primary means of marine access to Upper New York Bay and more recently to Port Newark-Elizabeth Marine Terminal in Newark Bay.

Besides the Hudson River, the Hudson-Raritan Estuary is connected to the Lower Passaic River and the Hackensack River through Newark Bay. This bay (approximately 6 miles long and 1 mile wide) is formed by the confluence of these two rivers and is connected to Upper New York Bay by the Kill van Kull and to Raritan Bay by the Arthur Kill.

Newark Bay is enclosed on the west by the New Jersey cities of Newark and Elizabeth and on the east by Jersey City and Bayonne. It is bordered on the south by Staten Island, New York. The banks of Newark Bay are home to numerous active and abandoned commercial and industrial properties. These banks are extensively developed and consist of miles of paved shoreline. Although originally a shallow tidal estuary, deep navigational channels are maintained in Newark Bay to accommodate ocean-going container ship access to Port Newark-Elizabeth Marine Terminal along its western side. There are also federally authorized navigational channels extending from Newark Bay into the Lower Passaic River and the Hackensack River.

2.4.3.2 The Lower Passaic River

The Passaic River, located in northern New Jersey, is approximately 80 miles long. Dundee Dam (which was built in 1845) is located at RM17.4 and divides the Upper Passaic River from the Lower Passaic River (Figure 2-1). The Upper Passaic River meanders across several geologic settings, draining urban, suburban, and rural portions of New Jersey. The Upper Passaic River watershed includes 16 Superfund sites and 2,216 New Jersey Known Contaminated Sites. Soils and groundwater at these sites are contaminated with an array of chemicals. For example, Witco Chemical Corporation (Oakland, New Jersey; located in the Upper Passaic River watershed but not directly along the bank of the river) operated a facility that discharged wastewater in a network of unlined subsurface seepage pits. This discharge resulted in groundwater contaminated with petroleum hydrocarbons and soils contaminated with pesticides and heavy metals, including mercury, cadmium, and lead (USEPA, 2006a). Another site is Caldwell Trucking Corporation (Fairfield, New Jersey; also located in the Upper Passaic River watershed but not directly along the bank of the river), which is contaminated with residential, commercial, and industrial septic waste. Soils were reported to contain Total PAH, Total PCB, and heavy metals (USEPA, 2006b).

The Lower Passaic River is divided into three river sections, as noted above in Section 2.3 "Scope and Role of Response Action," and is bounded by the Dundee Dam and Newark Bay (Figure 2-6). In general, freshwater and solids flow over the Dundee Dam, enter the Freshwater River Section, and flow downriver to Newark Bay. Saline water from Newark Bay moves upriver beneath the freshwater flow. The mixing of fresh and saline waters creates the Brackish and Transitional River Sections. Solids originating above the dam, solids eroding along the length of the river, solids transported upriver from Newark Bay, and those solids discharged from other sites (including combined sewer overflows (CSOs) and tributaries) are continuously mixed by tidal action, resuspending and redepositing surface sediment. These processes cause the continuous re-working of fine-grained sediments on the surface of the river bed.

Dated sediment cores that document the magnitude of the historical contaminant loads to the Lower Passaic River record similar loading histories, despite the distance separating the cores. This observation is direct evidence of the effectiveness of tidal mixing in the Lower Passaic River, where sediments are well homogenized prior to deposition. Moreover, the presence or absence of an interval of high concentration within the sediments at a given location is a function of the depositional history and is not controlled by proximity to source. Thus, thick sequences of contaminated sediments will tend to have similar inventories of contaminants throughout the Brackish River Section and even into the Transitional River Section of the river (Malcolm Pirnie, Inc., 2007a).

2.4.4 Sediment Characteristics

2.4.4.1 Data Sources Used to Characterize Sediments

Numerous data sources were considered and utilized in the various data analysis and modeling efforts on which the development of active remedial alternatives for the Area of Focus was based. Table 2-2 summarizes the data sets presented in the Conceptual Site Model (Malcolm Pirnie, Inc., 2007a) that were used to develop a thorough understanding of site characteristics and site processes. These data sets were supplemented with literature data that are referenced in the CSM.

Table 2-2: Data Sets Presented in the CSM (Malcolm Pirnie, Inc., 2007a)

Study Name [1]	Sample Year	Number of Locations	River Mile or Water Body	Type of Sample
1990 Surficial Sediment Investigation	1990	3 [2]	Above Dundee Dam	Sediment Grab
1991 Core Sediment Investigation	1991	1 [2]	Above Dundee Dam	Sediment Core [3]
1995 Remedial Investigation Sampling Program	1995	97	RM0.9 to RM6.8	Sediment Core [3],[4]
1999 Sediment Sampling Program	1999	1 [5]	RM6.2	Sediment Core [3]
1999 Late Summer/Early Fall Environmental Sampling Program	1999	45	RM1 to RM6.9	Sediment Grab
1999/2000 Minish Park Monitoring Program	1999	8	RM4.9 to RM5.1	Sediment Core [3]
2000 Spring Environmental Sampling Program	2000	15	RM1 to RM6.9	Sediment Grab
Newark Bay 2005 Remedial Investigation Work Plan Phase 1 Dataset	2005	69	Newark Bay	Sediment Core [3]
2005-2006 USEPA Sampling Program High Resolution Cores	2005	5	RM1.4 to RM12.6	Sediment Core [3],[4]
2005-2006 USEPA Sampling Program Low Resolution Cores	2006	10	RM2.8 to RM6.8	Sediment Core [3]

[1] Data are available at www.ourPassaic.org.
[2] Only sample locations above the Dundee Dam were evaluated.
[3] Only surface sediment samples are presented in the CSM.
[4] All data from sediment core were evaluated to develop the CSM.
[5] Only one sampling location was incorporated into CSM since the other samples were mis-projected.

Table 2-3 provides an additional list of data sets evaluated in the Draft Geochemical Evaluation (Step 2) (Malcolm Pirnie, Inc., 2006c). The conclusions from these evaluations were summarized and presented throughout the CSM.

Table 2-3: Data Sets Referenced in the Draft Geochemical Evaluation (Step 2) (Malcolm Pirnie, Inc., 2006c)

Study Name [1]	Sample Year	Number of Locations	River Mile or Water Body	Type of Sample
1990 Surficial Sediment Investigation	1990	2 [2]	RM3.2 to RM7	Sediment Grab
1991 Core Sediment Investigation	1991	14 [2]	RM0.2 to 7	Sediment Core [3]
2004 Newark Bay Remedial Investigation Work Plan	1991-1998	32	Newark Bay	Sediment Core [4]
1992 Core Sediment Investigation	1992	4 [2]	RM1.1 to RM7	Sediment Core [4]
1993 Core Sediment Investigation – Part 1 (March 1993)	1993	8 [2]	RM0.3 to RM7	Sediment Core [3]
1993 Core Sediment Investigation – Part 2 (July 1993)	1993	11	RM0.5 to RM3	Sediment Core [3]
1994 Surficial Sediment Investigation	1994	18 [2]	RM3.5 to RM7.8	Sediment Grab
1995 Remedial Investigation Sampling Program	1995	97	RM1 to RM6.8	Sediment Core [3]
1995 Sediment Grab Sampling Program	1995	7	RM2.4 to RM2.7	Sediment Grab
1995 USACE Minish Park Investigation	1995	10	RM3.7 to RM5.5	Sediment Core [3]
1996 Newark Bay Reach A Sediment Sampling Program	1996	4	Newark Bay	Sediment Core [4]
1998 Newark Bay Elizabeth Channel Sampling Program	1998	3	Newark Bay	Sediment Grab and Sediment Core [4]
1999 Late Summer/Early Fall Environmental Sampling Program	1999	45	RM1 to RM6.9	Sediment Grab
1999 Newark Bay Reach ABCD Baseline Sampling Program	1999	10	Newark Bay	Sediment Grab
1999 Sediment Sampling Program	1999	1 [5]	RM6.2	Sediment Core [4]
1999/2000 Minish Park Monitoring Program	1999	8	RM4.9 to RM5.1	Sediment Core [4]
2000 Spring Environmental Sampling Program	2000	15	RM1 to RM6.9	Sediment Grab

[1] Data are available at www.ourpassaic.org.
[2] Only sampling locations between RM0 and RM7 were evaluated.
[3] All data from the sediment core were evaluated in the *Draft Geochemical Evaluation (Step 2)* (Malcolm Pirnie, Inc., 2006c).
[4] Only surface sediment samples were evaluated in the *Draft Geochemical Evaluation (Step 2)*.
[5] Only one sampling location was incorporated into *Draft Geochemical Evaluation (Step 2)* since the other samples were mis-projected.

Table 2-4 presents the specific, refined sampling efforts that were selected to best quantify the contribution of the various sources of contamination to the Lower Passaic River; these source evaluations are summarized in the EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b).

Table 2-4: Field Sampling Programs Considered in the EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b)

Source or Receptor	Field Sampling Program Considered	Number of Locations
Lower Passaic River	2005 USEPA High Resolution Sediment Coring Program	5
	2005 USEPA Large Volume Water Column Program	1
	2005 USGS Water Monitoring Data (collected during the NJDOT Environmental Dredging Pilot Study)	2
Newark Bay	2005 TSI Remedial Investigation Phase 1 dataset	16
Dundee Dam	2007 USEPA Sediment Coring Program	1
Tributaries	2005 USEPA Semi-permeable Membrane Device (SPMD) Deployments	4
	2005 USEPA Small Volume Water Column Program	4
CSO/SWOs	2001-2004 Contaminant Assessment and Reduction Program dataset	8

USGS – United States Geological Survey
CSO/SWO – Combined sewer overflow/stormwater outfall

In addition to the data sets presented above, it is important to note that numerous non-chemical data sets (*e.g.*, bathymetry data, data obtained from geotechnical sediment cores, sediment texture data) have been critical in refining the understanding of site processes.

High resolution sediment cores (or "dated sediment cores"; listed in Table 2-2 and Table 2-4 above) have played an integral role in the geochemical evaluations and mass balance modeling efforts to date. Data from these cores have proven to be a powerful tool and have been used extensively. High resolution sediment cores document the history of contaminant inputs, transport, and transformation. Differences among contaminant histories in high resolution sediment core records can document the introduction and approximate location of contaminant sources. High resolution sediment cores can document the degree to which contaminated sediments are mobilized in the river during extreme flows; this is critical in evaluating remedial alternatives. Additionally, contaminant histories and associations derived from high resolution sediment cores can provide a basis to limit future analytical costs (Malcolm Pirnie, Inc., 2005c).

To summarize their importance, high resolution sediment cores can help to:

- Understand contaminant distribution in the Lower Passaic River as a function of distance along the river.

- Understand the long-term fate of contaminants within the sediments, such as long-term transformation processes.

- Document the effects of past events, such as the impacts of major storm events, on sediment beds (as an empirical indicator of sediment stability during extreme events) and the introduction of contaminants to the river.

- Provide data on time-dependent functions (*e.g.*, mixing and source inputs).

- Augment the calculation of contaminant mass and sediment volumes based on finer sampling intervals and more accurate estimation of sedimentation rates than can be achieved by low resolution sediment cores and bathymetric surveys alone, since these cannot provide a complete historical picture of the contaminant inputs or accumulation.

- Provide additional data to understand the complex interactions of contaminants, sediments, time, river flow and tide, and adjacent water bodies.

- Provide information on current sources and loads as context for assessing the effectiveness of remedial alternatives, including providing a basis to evaluate the potential for recontamination from adjacent water bodies.

2.4.4.2 COPCs and COPECs in Sediments

The list of COPCs and COPECs in the sediments of the Lower Passaic River was developed for the Risk Assessment (Appendix C of the FFS; Malcolm Pirnie, Inc., 2007b) and is summarized in Table 2-5.

Table 2-5: COPCs and COPECs in the Sediments of the Lower Passaic River

Chemical Class	Chemical Name
Metals	Copper
	Lead
	Mercury
PAH	LMW [1]
	HMW [2]
PCB	Total PCB [3]
	TEQ for PCB
Pesticides	Total Chlordane
	Dieldrin
	DDD [4]
	DDE [4]
	DDT [4]
	Total DDT [4]
PCDD/F	2,3,7,8-TCDD
	TEQ for PCDD/F

[1] LMW PAH is defined as the sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene with samples flagged as not detected incorporated into the summation as zero.
[2] HMW PAH is defined as the sum of benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, indeno[1,2,3-c,d]pyrene, and pyrene with samples flagged as not detected incorporated into the summation as zero. Total PAH is the sum of HMW PAH and LMW PAH.
[3] Total PCB is defined as the sum of 209 PCB congeners with samples flagged as not detected incorporated into the summation as zero.
[4] DDD, DDE, and DDT refers only to the 4,4'-isomers. Total DDT is defined as the sum of DDD, DDE, and DDT.

2.4.4.3 Nature and Extent of Sediment Contamination

One important observation from the lateral and vertical extent of chemical contamination in the Lower Passaic River is the extent of tidal mixing throughout the river. Recently-deposited sediments throughout the Lower Passaic River have very similar, and elevated, concentrations of contaminants, indicating that sediments are well-homogenized prior to deposition. Thus, the presence or absence of an interval of high concentration within the sediments at a given location is a function of the depositional history at that location and is generally not controlled by proximity to source. As a result, thick sequences of contaminated sediments will tend to have similar inventories of contaminants regardless of their location in the river.

Contaminant inventories are not evenly distributed and vary along the length of the Lower Passaic River, with maximum values occurring near the areas encompassing RM1 to RM2, RM3 to RM4, and RM6 to RM7 (Figure 2-7). The coring data that form the basis for these inventories show a high degree of local spatial heterogeneity, indicating that discrete areas of relatively higher concentrations typically described as "hot spots" likely do not exist. Instead, the data indicate the presence of "hot zones" of the river on the scale of a mile or more, nearly bank to bank (*i.e.*, the width of the navigation channel plus historical berth areas) in lateral extent. This conclusion does not, however, diminish the significance of potential historic or current point sources as the origin of contaminant inventory in the Lower Passaic River. Estuarine mechanisms are believed to quickly render contaminant concentration gradients indistinct on the scales examined here. It is possible, however, that environmental sampling on a finer scale (on the order of less than a quarter mile) would identify very localized gradients near prominent historic or current source areas.

The legacy of sediment contamination in the Lower Passaic River likely extends back at least to the mid-nineteenth century, as illustrated by the vertical extent of contamination in the sediments. The oldest contaminants found in the sediments are PAH compounds, cadmium, mercury, and lead, which probably pre-date the turn of the twentieth century. Following these contaminants are, in order of chronological appearance in the river, DDT; 2,3,7,8-TCDD; and PCB. Other contaminants, such as arsenic, chromium, and copper are also present in the sediment record. The vertical extent of these contaminants is illustrated schematically in Figure 2-8. Details of the geochronology of these chemical classes and the patterns in surface sediment concentration are further described below.

2.4.4.3.1 History of Sediment Contamination: Summary of Sediment Geochronological Analysis

Dated sediment cores for the Lower Passaic River (RM1 to RM7) from the 1995 TSI data set show that the major releases of 2,3,7,8-TCDD began in the late 1940s to early 1950s and peaked in the late 1950s to early 1960s. The diagnostic ratio of 2,3,7,8-TCDD/Total TCDD of 0.7 to 0.8 can be used to trace Lower Passaic River PCDD throughout the Newark Bay complex and over the last 60 years. Based on dated sediments cores, this diagnostic ratio is observed throughout the sediments of the Lower Passaic River as far back as the 1950s. Prior to 1950, however, the 2,3,7,8-TCDD/Total TCDD ratio declines to a value of 0.1, approaching the value of 0.06, which is characteristic of sewage and atmospheric fallout (Chaky, 2003). The 2006 low resolution sediment cores indicated that the sand layer underlying the fine-grained sediment beds is not contaminated with 2,3,7,8-TCDD.

Dated sediment cores reveal that Total DDT discharges to the Lower Passaic River begin in the 1930s and peak in the late 1940s or early 1950s, consistent with the observations of Bopp *et al.* (1991a). Results consistently show measurable Total DDT concentrations occurring deeper in the sediment core than measurable 2,3,7,8-TCDD concentrations.

Total PCB contamination is distributed throughout the Lower Passaic River with peak concentrations [4 to 18 milligrams per kilogram (mg/kg)] occurring in the sediments dating to the 1960s or later. Hence, the extent of Total PCB contamination in the sediment beds is shallow when compared to mercury, lead, 2,3,7,8-TCDD, and Total DDT. Aroclor 1248 is the most commonly reported PCB mixture, typically comprising 60 percent or more of the Total PCB burden.

Total PAH contamination is unique in its temporal distribution, with the highest concentrations observed in the deepest core layers, gradually declining to the most recent deposition. The presence of Total PAH contamination in the sand layer underneath the thick silt deposits may represent historic deposition or alternatively a contaminated groundwater source. Ratio analysis of Total PAH shows that the majority of PAH contamination in the sediments is derived from combustion-related processes (Malcolm Pirnie, Inc., 2006c). The ratio "fingerprint" suggests that the majority of PAH contamination in the sediments is derived from combustion-related processes, including coal tar residue (a by-product of manufactured gas plant processes) and urban background combustion. Of these, coal tar wastes are historically the dominant source to the Lower Passaic River based on the prevalence of coal tar-like PAH ratios in more-contaminated sediments. The same analysis essentially rules out creosote-derived contamination and suggests that only minor portions of the sediment PAH contamination are derived from a petrogenic source (*e.g.*, oils spills).

Dated sediment cores from the TSI 1995 data set indicate that major contamination of heavy metals likely occurred in the 1930s or earlier. Elevated concentrations of arsenic (approximately 60 mg/kg), chromium (approximately 800 mg/kg), copper (approximately 700 mg/kg), lead (approximately 700 mg/kg) occur at depth in dated sediment cores, usually reaching a maximum at core bottoms. This evidence indicates that the vertical extent of these contaminants is undefined and that major inventories of these contaminants most likely lie below the documented depth of 2,3,7,8-TCDD contamination. Dated sediment cores were also unable to establish the depth of contamination for mercury and cadmium although peak concentrations; however, the analysis of 2006 low resolution sediment cores indicated that the sand layer underneath the fine-grained sediment beds was contaminated with mercury as well as other metals.

The presence of mercury and the other contaminants at this depth suggests that they may have been present in the Lower Passaic River since the time of the original construction of the navigational channel.

2.4.4.3.2 Sediment Concentrations

Patterns and trends in surface sediment concentrations based on the 1995 TSI data set were presented in the Draft Geochemical Evaluation (Step 2) (Malcolm Pirnie, Inc., 2006c). For the 1995 data set, most of the contaminants examined have no trend, yielding no evidence to suggest multiple sources. The concentrations of three metals (arsenic, chromium, and mercury) statistically increased in the downriver direction, suggesting the possibility of two sources, one at each end of the Lower Passaic River. Meanwhile, lead and PAH had a statistically decreasing trend downriver, suggesting that their primary source exists upriver of RM 7. However, while trends were identified in these data sets, low regression coefficients and high variability only weakly support the presence of a second source with typical concentration changes of 50 percent or less. For most contaminants, tidal mixing is sufficient to homogenize the impacts of local loads, resulting in no significant gradients in the Lower Passaic River.

The EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b) used a specific set of contaminants (including contaminants other than COPCs and COPECs as appropriate) to further characterize the Study Area. The average surface sediment concentrations of select contaminants (as presented in the EMBM) in recently deposited sediments are presented in Table 2-6. [Note that a separate set of average surface sediment concentrations were calculated as part of the Risk Assessment (Appendix C of the FFS; Malcolm Pirnie, Inc., 2007b); these data are not presented here.]

The data in Table 2-6 are derived from analysis of the top segments of five high-resolution sediment cores collected at various locations in the river. Recently-deposited surface sediments in the Lower Passaic River are defined as those deposited during the

2003-2005 time period. Table 2-6 also presents length-weighted average (LWA) concentrations of select contaminants in the Lower Passaic River using down-core data from the same five sediment cores. LWA concentrations represent a method of describing concentrations potentially available for resuspension. LWA concentrations integrate the entire thickness of contaminated sediments into one value for each contaminant, equivalent to the river eroding and resuspending sediment from all possible historical sediment layers on a roughly equal basis. [The EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b) provides more detail on the calculation of average surface sediment concentrations and LWA concentrations.]

Table 2-6: Lower Passaic River Average Surface Sediment Concentrations and LWA Concentrations for Select Contaminants (modified from Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b)

Analyte	Average Surface Sediment Concentration (RM1.4, RM2.2, RM7.8, RM11, and RM12.6) (1)	LWA Concentration
Mercury (mg/kg)	1.8	5.7
Lead (mg/kg)	210	420
Cadmium (mg/kg)	3.6	11
Trans-Chlordane (µg/kg)	33	44
DDE (µg/kg)	54	200
2,3,7,8-TCDD (ng/kg)	280 (2)	3,600 (2)
Total TCDD (ng/kg)	420 (2)	4,100 (2)
BZ 31 (µg/kg)	26	270 (2)
BZ 52 (µg/kg)	35	270 (2)
BZ 61+66+70+74+76 (µg/kg)	85	640 (2)
BZ 83+99 (µg/kg)	21	110 (2)
BZ 90+101+113 (µg/kg)	34	180 (2)
BZ 93+95+98+100+102 (µg/kg)	28	150 (2)
BZ 110+111+115 (µg/kg)	35	190 (2)
BZ 129+138+158+160+163+164 (µg/kg)	45	170 (2)
BZ 139+140+147+149 (µg/kg)	34	130 (2)
BZ 170 (µg/kg)	11	33 (2)
BZ 180+193 (µg/kg)	27	80 (2)

Analyte	Average Surface Sediment Concentration (RM1.4, RM2.2, RM7.8, RM11, and RM12.6) [(1)]	LWA Concentration
Benz[a]anthracene (mg/kg)	3.1	3.7
Benzo[a]pyrene (mg/kg)	3.6	3.7
Chrysene (mg/kg)	4.3	5.1
Fluoranthene (mg/kg)	6.5	8.2
Indeno[1,2,3-cd]pyrene (mg/kg)	2.9	2.6
Pyrene (mg/kg)	6.1	7.9

μg/kg – microgram per kilogram
ng/kg – nanogram per kilogram
(1) RI/FS river mile system is used.
(2) Average concentration for only three river locations (RM1.4, RM2.2, and RM11). RI/FS river mile system is used.
Concentrations rounded to two significant figures, whenever possible.

2.4.4.4 Sources of Sediment and Contamination

An empirical mass balance approach (see Section 2.4.6.1 "Empirical Mass Balance Model") was used to understand the relative importance of the sources of sediment and associated contamination to the Lower Passaic River. In general, external contaminant sources (by themselves) cannot account for the observed COPC concentrations in Lower Passaic River surface sediments, indicating that an internal source, or more specifically, resuspension of legacy sediments, is contributing to the contaminant burden of recently deposited surface sediments in the river (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b). Surface sediments that accumulate in the Lower Passaic River are comprised of solids that originated from the Upper Passaic River (located above the Dundee Dam), Newark Bay, major tributaries (including the Saddle River, Second River, and Third River), CSO/SWOs, and river-bottom sediment resuspension (Figure 2-9). As a fraction of the total solids flux to the Lower Passaic River, resuspension of legacy sediments (*i.e.*, the historical inventory; referred to as Lower Passaic River Integrated Sediment) comprises about 10 percent of the total annual deposition. The relative contributions from the Upper Passaic River and Newark Bay are roughly equal with respect to solids, comprising approximately 40 percent each. In terms of the contaminant loads, however, the Upper Passaic River is clearly the more important of the two (see below). Tributaries and CSO/SWOs account for the remaining 10 percent of solids contribution to the Lower Passaic River.

As part of the EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b), ratio analysis of several organic constituents has permitted the "fingerprinting" of the source material. Using these techniques, 2,3,7,8-TCDD contamination is shown to be derived almost exclusively from resuspension of legacy sediments (which were contaminated by historical industrial discharges) in the Lower Passaic River (Figure 2-10). Results of the EMBM indicate that the Upper Passaic River is the dominant source of PAH compounds to the Lower Passaic River, accounting for at least 50 percent of the contaminant load and often much more [as illustrated by benzo[a]pyrene and fluoranthene (both HMW PAH compounds); Figures 2-11 and 2-12]. PAH patterns indicate that the majority of PAH contamination in the sediments is derived from combustion-related processes, particularly coal tar waste. For PCB, there are two main sources to the Lower Passaic River of roughly equal magnitude. The resuspension of legacy sediments contributes a mixture of low molecular weight PCB congeners (as illustrated by BZ 52; Figure 2-13) while the flow from the Upper Passaic River contributes a higher molecular weight PCB mixture (as illustrated by BZ 180+193; Figure 2-14). The combination of the resuspension of legacy sediments and the flow from the Upper Passaic River account for nearly 75 percent of the DDE contaminant burden to the river (Figure 2-15). Sources of mercury contamination to the Lower Passaic River are similar to those for DDE (Figure 2-16). The mass balance for lead indicates roughly equal contaminant contributions from five sources (resuspension of legacy sediments, flow from the Upper Passaic River, flow from Newark Bay, flow from major tributaries, and CSO/SWO discharges), approximately 20 percent each (Figure 2-17).

The CSM demonstrates that toxic constituent concentrations in the water column (*i.e.*, dissolved concentrations) and in biota (*i.e.*, tissue concentrations) of the Lower Passaic

River are largely driven by solid-bound contamination (*i.e.*, associated with sediments and resuspended solids), particularly for 2,3,7,8-TCDD (Malcolm Pirnie, Inc., 2007a). While on-going external inputs may exist, solid-bound concentrations are responsible for much of the dissolved contamination within the water column.

2.4.4.5 Estimated Volume of Contaminated Sediment and Associated Mass of Contaminants

The combination of the navigational dredging activities and the long and extensive history of contaminant discharges to the Lower Passaic River have served to create a uniquely large inventory of highly contaminated sediments contained within a relatively small area. Other major Superfund sites may have similar volumes of contaminated sediments [*e.g.*, Hudson River PCB site at 2.6 million cubic yards (USEPA, 2002b) and Fox River PCB site at 8 million cubic yards (USEPA, 2003)], but these inventories are spread over much greater distances than the 17 miles of the Lower Passaic River. While data are not sufficient to assess the volume of contaminated sediment for the entire Lower Passaic River, the volume is estimated at 5 to 8 million cubic yards for RM0.9 to RM7, with an average depth of contamination ranging from 7 to 13 feet. The evidence from sidescan sonar and bathymetric surveys suggests that the conditions observed in RM0.9 to RM7 probably also apply over the area of RM0 to RM8, suggesting that the actual inventory of contaminated sediments is at least one-third greater than the values obtained in the Draft Geochemical Evaluation (Step 2) (Malcolm Pirnie, Inc., 2006c). Extrapolation of the estimated contaminant sediment volume into RM0 to RM1 and RM7 to RM8 results in an estimate of 6 to 10 million cubic yards of contaminated sediment in RM0 to RM8.

The volume of 2,3,7,8-TCDD-contaminated sediments is somewhat smaller than the overall contaminated sediment volume, since several contaminants are present at greater depths than 2,3,7,8-TCDD. The estimate of 2,3,7,8-TCDD-contaminated sediment volume ranges from 5 to 6.5 million cubic yards for RM0.9 to RM7.

The mass of contaminants contained within the sediments is also quite large (Table 2-7). Moreover, the mass of 2,3,7,8-TCDD represents one of the largest site inventories in the United States.

Table 2-7: Summary of Contaminant Inventory Estimates for RM0.9 to RM7

Inventory Estimate [1]	Total DDT (metric tons)	2,3,7,8-TCDD (kilograms)	Mercury (metric tons)	Total PCB (metric tons)
Based on measured core intervals only	6.4	20	24	6
Based on measured and extrapolated core profiles	11	29	37	8
Percent Increase [2]	72 percent	45 percent	54 percent	33 percent

[1] Based on information provided in the Draft Geochemical Evaluation (Step 2) (Malcolm Pirnie, Inc., 2006c).
[2] Percent increase is relative to the interpolated mass estimate.

2.4.4.6 RCRA Hazardous Wastes and Affected Media

On-site remedial actions conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) must comply with (or receive a waiver for) requirements of the Resource Conservation and Recovery Act (RCRA) that are determined to be ARARs. The USEPA has determined that sediments from the Lower Passaic River do not contain a listed hazardous waste. Thus, a data analysis was performed as part of the FFS (Malcolm Pirnie, Inc., 2007b) to determine whether sediment from the Lower Passaic River could be classified as a characteristic waste due to toxicity as defined through the Toxicity Characteristic Leaching Procedure (TCLP).

TCLP data are not available for Lower Passaic River sediments. However, in lieu of the TCLP extraction, Section 1.2 of the TCLP procedure (USEPA Method 1311; USEPA, 1992) allows for a total constituent analysis which may be divided by 20 to convert total results into the maximum hypothetical leachable concentration. This factor is derived from the 20:1 liquid-to-solid ratio employed in the TCLP method. Additional information on the use of the total constituent analysis in lieu of the TCLP method is described in the USEPA's "Monthly Hotline Report: Hotline Questions and Answers" (1994). The total constituent analysis was performed on maximum sediment concentrations from Lower Passaic River sediment cores collected in 1991, 1993, and 1995. Appendix H of the FFS (Malcolm Pirnie, Inc., 2007b) contains further detail on the methodology and the results of this analysis. The results are summarized in Table 2-8.

Table 2-8: Percentage of Sediment Samples that Could Exceed Toxicity Characteristic Thresholds for Various Analytes

Contaminant	Exceedance Percentage
1,4-Dichlorobenzene	2.5
2,4,6-Trichlorophenol	0.14
2.4-D	0.18
2.4-Dinitrotoluene	0.14
Arsenic	1.5
Cadmium	13
Chlordane	0.14
Chromium	73
Endrin	0.28
Hexachlorobenzene	0.66
Lead	83
Mercury	53
Selenium	0.15

The analysis concluded that there is a reasonable probability that some sediment from the Lower Passaic River could exceed toxicity characteristic criteria if the TCLP test were performed; this likelihood has been accounted for in development of scenarios for dredged material management. In particular, based on this analysis, the analytes most likely to exceed the toxicity characteristic thresholds are chromium, lead, and mercury. However, it has not yet been determined whether sediment from the Lower Passaic River will, in fact, be classified as a RCRA hazardous waste; this must be resolved by further investigation during design.

2.4.4.7 Impacts of the Lower Passaic River to Newark Bay

The Lower Passaic River is the main source of freshwater to Newark Bay and a major source of contaminants to the bay as well. Solids delivered from the Lower Passaic River to Newark Bay contain contaminant levels similar those found in surficial sediments of the Lower Passaic River. As a result, for several contaminants examined, the history of contamination observed in the Lower Passaic sediments is also observed in Newark Bay. For example, dated sediment cores for the Lower Passaic River (RM0.9 to RM7) are consistent with the observations by Bopp *et al.* (1991a and 1991b) and Chaky (2003) for Newark Bay, specifically that the major releases of 2,3,7,8-TCDD begin in the late 1940s to early 1950s and peak around the late 1950s to early 1960s. The history of Total DDT releases observed in the Lower Passaic River was also consistent with the observations for Newark Bay made by Bopp *et al*. The diagnostic ratio of 2,3,7,8-TCDD/Total TCDD of 0.7 to 0.8 can be used to trace Lower Passaic River 2,3,7,8-TCDD contamination throughout the Newark Bay complex. Recent surficial samples from Newark Bay suggest the mixing of high ratio, high 2,3,7,8,-TCDD concentration sediments from the Lower Passaic River with somewhat lower ratio, lower concentration sediments from the Arthur Kill and Kill van Kull, creating gradients in the ratio and the 2,3,7,8,-TCDD concentration across Newark Bay

Mass balance analysis performed on Newark Bay suggests that the Lower Passaic River contributes approximately 10 percent of the total amount of solids accumulating in Newark Bay, but more than 80 percent of the 2,3,7,8-TCDD accumulating in the Bay (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b). No other single source delivers more than 10 percent of the total 2,3,7,8-TCDD load. predecisional -deliberative

predecisional -deliberative

2.4.5 Groundwater and Surface Water Contamination

Investigations to date and the EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b) focused on sediment solids and chemicals that are predominantly associated with sediments. Therefore, the importance of groundwater and other releases of contamination in the dissolved phase were not evaluated.

2.4.6 Models Used to Further the CSM

2.4.6.1 Empirical Mass Balance Model

A chemical mass balance approach similar to USEPA's Chemical Mass Balance (CMB) model (Watson *et al.*, 2004) was used for the Lower Passaic River EMBM Analysis. The USEPA CMB model is applied in air pollution studies for particulate matter and volatile organic compounds. Recently, CMB type-formulated models have been applied to sediment contamination sites that are contaminated with PCB, PCDD/F, and PAH compounds. Examples of these sediment contamination sites include Fox River in Wisconsin (Su *et al.*, 2000), Ashtabula River in Ohio (Imamoglu *et al.*, 2002), Lake Calumet in Chicago (Bzdusek *et al.*, 2004), and Tokyo Bay and Lake Shinji in Japan (Ogura *et al.*, 2005).

The input parameters to the EMBM were the measured concentrations of the various chemicals in the different sources of contamination to the Lower Passaic River. These sources included Newark Bay, the Upper Passaic River, major tributaries (Saddle River, Second River, and Third River) to the Lower Passaic River, CSOs and SWOs, and resuspension of legacy sediments. Furthermore, watershed solids yield and watershed areas available from the USGS were used to formulate model constraints. The chemical signatures of the sources were obtained from several data sources including the Lower Passaic River high resolution sediment core program, the Lower Passaic River large volume water column sampling program, the Lower Passaic River tributaries small volume and SPMD water column sampling programs, the Newark Bay Remedial Investigation Phase 1 dataset, the Dundee Dam sediment core program, and the NJDEP combined stormwater and sewer overflows sampling program.

There are uncertainty and variability in the measured concentrations used in the EMBM. The uncertainty and variability in both source profiles and receptor concentrations were evaluated using a Monte Carlo approach. In this approach, a distribution was specified for each concentration based on the observed values, and the mass balance calculations were repeated 5000 times using randomly selected concentrations for the sources and receptor. The output of the Monte-Carlo analysis provided ranges of solids contribution from the various sources.

2.4.7 Areas of Archaeological or Historical Importance

Formal cultural resource surveys have not yet been conducted for the Lower Passaic River. However, a geophysical survey of the Lower Passaic River was conducted by Aqua Survey, Inc. (Aqua Survey, Inc., 2006) along the majority of the 17-mile Study Area. One of the objectives of the survey was to provide archaeological data essential for complying with the National Historic Preservation Act of 1966, as amended, through 1992 and the Abandoned Shipwreck Act of 1987. The survey area included the river bottom within the channel from the confluence of the Passaic River with the Hackensack River to the abandoned railroad bridge between Newark and Kearny (located at approximately RM0.6). The survey also included the area from shoreline to shoreline above the abandoned bridge to approximately one mile below the Dundee Dam, at which point the river was too shallow for remote sensing equipment to operate effectively. Technologies employed in the geophysical survey included sidescan sonar, sub-bottom profiler, fathometer, magnetometer, real-time kinematic differential global positioning, shallow push coring, and deep vibracoring.

The sidescan sonar survey indicated the presence of one potentially historically significant submerged cultural resource located at approximately RM11.5. The item is a probable shipwreck and was identified as a sonar target with an associated magnetic anomaly. Note that this wreck is located outside of the Area of Focus for the Source Control Early Action.

Stage 1, and likely Stage 2, cultural resource surveys of the river bed will be conducted as part of the pre-design investigation (see Section 2.3 "Scope and Role of Response Action"). In addition to evaluation of the submerged river bed, mud flat and river bank areas that were not included in the geophysical survey due to shallow water depths should be assessed for the presence of historically significant artifacts and evidence of colonial/pre-industrial habitation and use. Based on the results of an initial survey in these areas, mud flats and the river banks may require further analysis in a Stage 2 investigation.

2.4.8 Summary of Conceptual Site Model

In summary, although the Lower Passaic River is a partially stratified estuary, the tidal excursion is sufficiently energetic that the water column remains well-mixed with respect to suspended solids. The tidal portions of the river have been subject to increased sedimentation rates resulting from historical dredging followed by decades of minimal maintenance dredging. The period of minimal maintenance dredging coincided with a period of significant discharge of industrial waste to the river. Subsequent re-filling of dredged channels due to the reduced maintenance during the period of industrial discharges and the combination of relatively well-mixed suspended matter and high deposition rates yielded thick sequences of contaminated sediment. For this reason, local variations in sediment contaminant inventory are primarily attributed to variations in depositional rates, and not proximity to local sources; however, the resolution of available data sets is not sufficient to eliminate the possibility of very localized areas of high contaminant concentrations in the immediate vicinity of point sources.

Surface concentrations in the Lower Passaic River are relatively homogeneous over long distances, with the range typically less than a factor of 3 along 12 miles or more of the river. The homogeneity of contaminant concentrations in the surface sediments over these large distances is a function of the energetic tidal mixing. Surface concentrations of many contaminants (*e.g.*, 2,3,7,8-TCDD) are maintained at high levels by erosion and resuspension of older, more contaminated sediments within the Lower Passaic River. Conversely, the concentrations of several important chemicals (*e.g.*, PAH) receive a significant input from external sources above the head-of-tide loads. Concentrations of some contaminants, such as PCB, are maintained by both head-of-tide influences and resuspension of legacy sediments. The continued elevated surface concentrations, resuspension of historic inventory, and tidal exchanges with down-stream water bodies provides a continuing source of contaminants to Newark Bay and the remaining New York Harbor Estuary.

2.5 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

2.5.1 Land Use

2.5.1.1 Current On-Site Land Use

The current land use characteristics of the banks of the Lower Passaic River are described in a Navigation Analysis (Appendix F of the FFS; Malcolm Pirnie, Inc., 2007b) prepared by the USACE in support of the FFS. The left bank (ascending) of the river between RM0.0 and RM4.6 (Newark, New Jersey) can best be characterized as fully industrially developed. The right bank (ascending) in this reach of the river is located in Harrison, New Jersey and is occupied by the railroad tracks of the Port Authority Trans Hudson system and by an intermodal container-handling facility. Transitional land use areas are located on both banks of the river upstream of the Jackson Street Bridge (RM4.6). The left bank in this area of the river is dominated by McCarter Highway (New Jersey Route 21) and Joseph G. Minish Waterfront Park, a current collaborative effort of the USACE, NJDEP, and the City of Newark. The right bank in this area of the river is being redeveloped for a combination of residential and recreational uses. Redevelopment transition can be seen at Clay Street in Newark on the left bank, where a complex of storage tanks appears to be in the process of being dismantled. McCarter Highway continues north along the left bank of the river (RM4.6 – RM15.4) to Dundee Dam. The right bank of this segment of the river is characterized as recreational parkland (containing at least one small public marina and a few private docking facilities for recreational craft) as well as some residential and light commercial land use areas. A recent examination of the river from adjacent roads revealed no storage tanks or facilities for commercial cargo vessels upstream of the tanks at Clay Street.

Current land use immediately adjacent to the Lower Passaic River, including the area located within the 100-year and 500-year floodplains, is predominantly urban, with some scattered areas of forested land and wetlands (Figure 2-18).

2.5.1.2 Current Adjacent/Surrounding Land Use

The current land use characteristics of New Jersey counties encompassing the Study Area are described below (Malcolm Pirnie, Inc., 2006a):

- <u>Bergen County</u>: Land use is 40 percent residential with 14 percent public and quasi-public open space and 12 percent undeveloped property. Commercial property accounts for only 3 percent of the total land use. Bergen County land use applies to the following communities in the Study Area: East Rutherford, Garfield, Lyndhurst, North Arlington, Rutherford, and Wallington. None of these communities are located along the 8-mile Area of Focus; all are upriver of this stretch.

- Hudson County: Land use is evenly mixed between residential, industrial, vacant property, and streets/right-of-way. Water occupies 9,840 acres or approximately one-fourth of the total area of the county. Hudson County land use applies to the communities of Harrison, Jersey City, Kearny, and East Newark. All of these communities abut the river in the Area of Focus.

- Essex County: Land use is highly industrialized, especially in the eastern part of the county abutting the river. Several colleges and universities are also located in the county. Essex County land use applies to the communities of Belleville, Newark, and Nutley. Of these, only Newark is located along the Area of Focus; the others are farther upriver of this stretch.

- Passaic County: Land use is a combination of residential, commercial, and industrial properties. The communities of Passaic and Paterson are mixed-use urban areas with high population density. Passaic County land use applies to the communities of Clifton and Passaic. Neither of these communities is located along the Area of Focus; both are farther upriver of this stretch.

2.5.1.3 Reasonably Anticipated Future Land Uses

Reasonably anticipated future land uses for land located immediately adjacent to the Lower Passaic River are described in Section 2.5.2.3 "Navigational Channel Depths to Accommodate Reasonably Anticipated Future Surface Water Uses" with the discussion of maintenance of the federal navigation channel to accommodate future uses of the corridor.

2.5.2 Surface Water Use: Navigation Requirements

The Lower Passaic River contains a federally-authorized navigation channel. From RM0 to RM7, the channel is authorized at 300 feet wide and at depths ranging from 30 feet mean low water (MLW) to 16 feet MLW; from RM7 to RM8, it is authorized at 200 feet wide and 16 feet (MLW) deep (specific details of the authorized dimensions are listed in Section 2.5.2.1 "Current Federally Authorized and Constructed Navigation Channel" below). The most recent dredging of the river occurred in 1983, when approximately 540,000 cubic yards of sediment were removed from the lower portion of the river near Newark (Ianuzzi, *et al*., 2002). Since that time, sediment deposition in the navigation channel has reduced the available draft to less than its authorized depth.

According to *Land Use in the CERCLA Remedy Selection Process* (USEPA, 1995b), remedial alternatives developed during the RI/FS should reflect reasonably anticipated future land use(s). On the shores of the Lower Passaic River, land use and navigation use (and thus navigation channel depth) are very often linked. In order to evaluate the channel dimensions necessary to accommodate current navigation usage, USACE-New York District conducted a survey of commercial stakeholders along the Lower Passaic River (Appendix F of the FFS; Malcolm Pirnie, Inc., 2007b). In order to evaluate the channel dimensions necessary to accommodate reasonably anticipated future usage of the river, the State of New Jersey conducted surveys of municipalities and other local organizations along the Lower Passaic River (Appendix F of the FFS; Malcolm Pirnie, Inc., 2007b). The results of these surveys are described below in Section 2.5.2.2 "Navigational Channel Dimensions to Accommodate Current Surface Water Uses" and 2.5.2.3 "Navigational Channel Depths of Accommodate Reasonably Anticipated Future Surface Water Uses".

2.5.2.1 Current Federally Authorized and Constructed Navigation Channel

The current federally authorized channel depths of the commercially navigable portion of the Lower Passaic River are as follows (Malcolm Pirnie, Inc., 2007b):

- RM0 to RM2.5: The federally authorized and constructed channel depth is 30 feet relative to MLW. A bridge abutment at RM1.2 limits channel width to 145 feet. The Point-No-Point Swing Bridge at RM2.5 limits channel width to 103 feet and limits vertical clearance to 16 feet at high water.

- RM2.5 to RM4.6: The federally authorized and constructed channel depth is 20 feet MLW.

- RM4.6 to RM7.1: The federally authorized channel depth is 20 feet MLW; however, the channel was only constructed to 16 feet MLW.

- RM7.1 to RM8.1: The federally authorized and constructed channel depth is 16 feet MLW.

- RM8.1 to RM15.4: The federally authorized and constructed channel depth is 10 feet MLW.

Since the 1940s, there has been little maintenance dredging above RM2. Consequently, the channel has extensively filled back in, particularly between RM2 and RM8.

2.5.2.2 Navigational Channel Dimensions to Accommodate Current Surface Water Uses

As part of the Navigational Analysis, the USACE conducted an evaluation of waterborne commerce conducted between 1980 and 2004 in the Lower Passaic River (Appendix F of the FFS; Malcolm Pirnie, Inc., 2007b). The analysis concluded that over 90 percent of cargo (mostly consisting of petroleum and petroleum products) transported along the river is carried in vessels loaded to less than 13 feet draft, with the exception of 13 records of vessels having 26-foot drafts in 2004. Because the bulk of these shipments occurred between RM0 and RM1.2 where the authorized and constructed depth is 30 feet, the analysis concluded that commercial navigation on the Lower Passaic River is most likely currently constrained by width rather than by depth. The width constraint is due to requirements associated with safe navigation: channel width should be at least five times the beam of the vessel for two-way traffic, and at least three times the beam of the vessel for one-way traffic, with beam defined as the width of a vessel at its widest point, usually mid-ship.

Based on USACE data, the dimensions of a navigation channel within the lower eight miles of the Lower Passaic River that would accommodate the current usage are as follows:

- RM0 to RM1.2: The authorized depth should be maintained at 30 feet MLW based on United States Waterborne Commerce data that indicate 13 barges requiring 26-foot drafts were recorded in 2004.

- RM1.2 to RM2.5: The authorized depth should be a minimum of 16 feet MLW based on the 5.5-foot tidal range in the lower 2.5 miles of the Passaic River. If the constructed depth falls below this threshold, maintaining safe passage will impose operational limitations to the timing of commerce, requiring shipments to coincide with high tide.

2.5.2.3 Navigational Channel Depths to Accommodate Reasonably Anticipated Future Surface Water Uses

Channel depths to accommodate future usage were considered by the State of New Jersey and were based on future use surveys for municipalities, an evaluation of market and land use scenarios for the Passaic River Region, statewide economic and revitalization programs, as well as the USACE Navigation Analysis (Appendix F of the FFS; Malcolm Pirnie, Inc., 2007b). The State's recommendations for a minimum depth requirement in each of the river reaches for future navigation are based on the three key pieces of information described below. These minimum depths would require maintenance in the future to preserve the uses stated.

Municipality Surveys for Future Use and Master Plans: Over 70 surveys were mailed to representatives (Mayors, Assemblymen, Senators, Congressmen) involved in planning for approximately 17 municipalities with the 17-mile Study Area. A total of 13 surveys were returned covering areas within Clifton, Rutherford, Nutley, East Rutherford, Belleville, Bloomfield, Kearny, East Newark, Harrison, Bayonne, and Elizabeth. In addition to the surveys, master plans from Newark, Harrison, Kearny, and Belleville were reviewed to identify potential future redevelopment initiatives. All surveys will be utilized for the overall FS and restoration planning for the entire 17-mile Study Area.

The surveys and master plans outline current and proposed land use patterns which are related to the overall depth required for such designated uses. The survey results indicate that the communities in the upper 9 miles of the Study Area reflect their objectives to enhance public access, preserve open space, and improve recreational uses (*e.g.*, boating, fishing, ecotourism, parks/fields) along the river. In addition, the Passaic River Boat Club (among other non-profit organizations) is working to improve waterfront access (*e.g.*, locations, adequate depths), provide facilities (*e.g.*, marinas, docks), and spearhead recreational regional events. The Lower Passaic and Saddle River Alliance has also proposed a Water Kayak and Canoe Trail from Pompton River (RM32) to the confluence with Newark Bay and up the Hackensack River. Future proposed use planning efforts are summarized in Figure 2-19.

USACE-New York District Lower Passaic River Navigation Analysis: The USACE conducted an analysis of past, current, and potential use of commercial entities located on the Passaic River. This study did not attempt to predict future use by the commercial facilities. The results of the USACE analysis and the USACE's recommended minimum channel depths are discussed in Section 2.5.2.2 "Navigational Channel Dimensions to Accommodate Current Surface Water Uses".

Additional Considerations for the State of New Jersey: The navigational recommendations of the State of New Jersey support the goals and objectives for many statewide programs, including: Brownfield Development, Portfields Initiatives, Smart Growth Initiatives, Comprehensive Statewide Freight Planning, the Long Range Transportation Plan, Transportation Choices 2030, State Development and Redevelopment Plan, and the Liberty Corridor Initiative. These programs are important considerations for the State of New Jersey with respect to future economic revitalization and development of the region, which could be arbitrarily constrained if the future authorized depth of the channel were insufficient to support the associated navigational requirements.

The area within Newark's Industrial Zone adjacent to and downstream of RM3.6 is considered a prime location by the State of New Jersey to support mixed-use economic growth and revitalization. The area within this zone has been designated as the Lister Avenue Brownfield Development Area (BDA) and slated for remediation and reuse. Specifically, the area between RM3.6 and RM2.5 (Blanchard Street/Fairmont Chemical Redevelopment Area) has been identified as a potential site in the Portfields Program and may be used to support Port operations through the placement of warehouse distribution operations. Other areas within the BDA (*e.g.*, Sherwin Williams, the Diamond Alkali Superfund Site, Hilton Davis) are in earlier stages of planning with uncertainties associated with their specific redevelopment. Based on these uncertainties, the significant private investment in Brownfield redevelopment, and the State's alignment of programs encouraging Brownfield redevelopment, the State desires to preserve future growth potential for this area to the maximum extent possible. Several divisions within NJDOT (Statewide Planning, Freight Planning and Intermodal Coordination, Office of Maritime Resources and Project Planning and Development) have determined that the minimum depth recommendations presented in the NJDOT memorandum support the goals and objectives of several statewide programs.

<u>NJDOT Minimum Depth Recommendations</u>: The NJDOT's recommendations for minimum depth requirements in the lower 8 miles of the Passaic River (that is, the Area of Focus) are summarized in Table 2-9.

Table 2-9: Summary of Current and Recommended Navigational Depths (Appendix F of the FFS; Malcolm Pirnie, Inc., 2007b)

Reach (RM)	Authorized Depth (feet)	Constructed Depth (feet)	Existing Average Depth and Range (feet)	Minimum Depth for Anticipated Future Use (feet)	Comments
0.0-1.2	30	30	Avg: 17.2 Range: 9.5-20.9	30	Maintain existing and future industrial use
1.2-2.5	30	30	Avg: 19.7 Range: 14.8-24.7	16	Preserve future potential industrial uses, brownfields, portfields
2.5-3.6	20	20	Avg: 15.2 Range: 13.0-18.4	16	Preserve future potential industrial uses, brownfields, portfields
3.6-4.6	20	20	Avg: 16.4 Range: 11.9-22.1	10	Future recreational and commercial services (*e.g.*, water taxis/ferries)
4.6-8.0	20 (RM4.6-RM7) 16 (RM7-RM8)	16	Avg: 15.7 Range: 5.1-21.9	10	Future recreational and commercial services (*e.g.*, water taxis/ferries)

- RM0.0 – RM2.5: The USACE has determined that current navigational use of the river could be accommodated by an authorized depth of 16 feet (vessels drafting 13 feet) within this reach. Waterborne Commerce of the United States data and current dredging permits indicate use by vessels requiring 26 feet. Based on the recent polling of existing users and examination of current permitted berth dredging, it appears that there is a need for commercial drafts of at least 26 feet today, specifically near the confluence of Newark Bay. Since current users of the river are located in the lower 1.2 miles of the river, the depth requirements for this reach could be divided into two segments:

    - RM0.0 - RM1.2: Facilities that are currently using the river justify maintaining the current authorized depth of 30 feet. The State of New

Jersey recommended maintaining the existing authorized depth of 30 feet in this segment.

- o <u>RM1.2 - RM2.5</u>: The depth is proposed to be not less than 16 feet based on future industrial users, brownfields, and portfields sites. Additional deliberation among the State of New Jersey and the cities of Newark and Kearny is planned to finalize the State's depth recommendation for this upper reach.

- <u>RM2.5 – RM3.6</u>: Although Newark's industrial zone above RM2.5 does not currently utilize the river for waterborne transportation purposes, the future plans for this segment may result in complete redevelopment of the area. The minimum depth requirement will be determined by future land use patterns following upland remediation. The State's recommendations consider the possibility of navigational use of the river for the Lister Avenue BDA, consistent with the Liberty Corridor Initiative, or for a use not yet identified. Therefore, the State has recommended a minimum depth of 16 feet in this segment to preserve the potential for future navigational use and economic revitalization of the region.

- <u>RM3.6 – RM4.6</u>: The State has recommended a minimum depth of 10 feet upstream of Newark's industrial zone and downstream of the Jackson Street Bridge. This depth is believed adequate to accommodate planned recreational and commercial services (*e.g.*, water taxis/ferries proposed at RM4.8) in the river as discerned from master plans and municipality surveys.

- <u>RM4.6 – RM8.0</u>: A primary goal of the Lower Passaic River Restoration Project is to improve public access and enhance recreational use of the river. The State's recommendations for river depths between Jackson Street and the Amtrak Bridge consider proposed water taxis/ferries within the river stretch. Future recreational uses and the possibility of commercial services (*e.g.*, water taxis/ferries) are considered for reaches upstream of the Amtrak Bridge. Most recreational vessels less than 30 feet in length have drafts of less than 3 feet; a depth of 5 feet would accommodate nearly all recreational vessels on the Passaic River. A minimum of 7 feet would accommodate all reasonably anticipated recreational uses. If commercial services considered a route upstream of the Amtrak Bridge, a depth of 10 feet would accommodate this potential need. It should be noted that limited bridge openings are a constraint for optimizing recreational use in the upstream reaches of the river.

2.5.2.4 Other Navigational Issues

In addition to navigation channel configuration, construction of berth areas is another component of navigation on the Lower Passaic River. Berth areas dredged historically to provide access from the channel to shoreside facilities may contain thick silt deposits associated with contaminant inventory. Locations of berth areas are neither comprehensively nor precisely known, although historical coring data showing thick beds of fine-grained contaminated sediments outside the authorized navigational channel boundary are suggestive. Dredged material management and monitoring and control of water column or sediment surface recontamination impacts associated with construction of future berth areas are likely to be addressed under local or state programs, although restrictions on dredging in capped areas would need to be imposed to maintain the integrity of the remedy.

2.6 SUMMARY OF SITE RISKS

To be addressed.

2.7 REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

RAOs were established to describe what the cleanup is expected to accomplish, and PRGs were developed as targets for the cleanup to meet in order to protect human health and the environment.

Risks are driven by highly contaminated surface sediment in the Lower Passaic River, and the remediation of surface sediment to the levels established by the RAOs and PRGs will significantly reduce risk to both human and ecological receptors. In addition, reduction of the source of contamination will reduce risks in Newark Bay and harborwide to some degree.

The EMBM (Appendix D of the FFS; Malcolm Pirnie Inc., 2007b) identified Newark Bay and the Upper Passaic River (above Dundee Dam) as major solids contributors to the Lower Passaic River. Cleanup levels for action in the lower eight miles of the river are proposed in consideration of these solids contributors.

2.7.1 Remedial Action Objectives

The RAOs were developed by the USEPA with input from the partner agencies regarding current and reasonably anticipated future uses of the site. The RAOs are as follows:

- Reduce cancer risks and non-cancer health hazards for people eating fish and shellfish from the Lower Passaic River by reducing the concentration of COPCs in fish and shellfish.

- Reduce the risks to ecological receptors by reducing the concentration of COPECs in fish and shellfish.

- Reduce the mass of COPCs and COPECs in sediments that are or may become bioavailable.

- Remediate the most significant mass of contaminated sediments that may be mobile (*e.g.*, erosional or unstable sediments) to prevent it from acting as a source of contaminants to the Lower Passaic River or to Newark Bay and the New York-New Jersey Harbor Estuary.

2.7.2 Preliminary Remediation Goals

PRGs are developed considering ARARs, RBCs, and the human health and ecological risks posed by the contaminants. The background contaminant contributions to a site also must be considered during PRG development to adequately understand contaminant sources and establish realistic risk reduction goals. Investigation of contaminants in the sediment of the Upper Passaic River above the Dundee Dam revealed historic and ongoing upstream sources of metals, pesticides, and PCB. These upstream sources are significant in comparison to contaminant concentrations in the Lower Passaic River. USEPA guidance defines "background" as levels of chemicals that are not influenced by releases from the site, including both anthropogenic and naturally derived constituents. The dam physically isolates the proximal Dundee Lake and other Upper Passaic River sediments from Lower Passaic River influences while the Lower Passaic River receives contaminant loads from above the dam. The proximity of these sediments to the proposed remediation area and demonstrated geochemical connection to a portion of the Lower Passaic River sediment contamination strongly argues in favor of considering the Upper Passaic River to be background for the Lower Passaic River. Given that the contaminant concentrations detected in sediment samples recently collected from the Upper Passaic River were found to be above the risk-based thresholds, the Upper Passaic River background concentrations were selected as PRGs.

During the evaluation and development of PRGs, several human health and ecological risk-based concentration thresholds were considered. These risk-based threshold concentrations were calculated from cancer risks and toxicity for human receptors who potentially consume between one and 40 meals of fish or shellfish a year from the river and from toxicity to ecological receptors including benthic organisms and wildlife (Appendix C of the FFS; Malcolm Pirnie, Inc., 2007b). As stated previously, when the risk-based concentration thresholds were compared to the background concentrations, the background concentrations were found to be higher and were therefore selected as the PRGs. Table 2-10 lists the background concentrations of COPECs and COPCs, selected as the PRGs (Malcolm Pirnie, Inc., 2007b).

Table 2-10: Selected PRGs

Contaminant	Background Concentration (ng/g)
Copper	80,000
Lead	140,000
Mercury [1]	720
Low Molecular Weight PAHs	8,900
High Molecular Weight PAHs	65,000
Total PCB	660
Total DDx	91
Dieldrin	4.3
Chlordane	92
2,3,7,8-TCDD	0.002

[1] All occurrences of mercury are assumed to be methylated for purposes of this evaluation.

Risk-based PRGs are presented in Tables 2-11 through 2-14 below (Malcolm Pirnie, Inc., 2007b).

Table 2-11: Summary of the PRGs Developed for Fish/Crab Tissue

COPC	PRGs [1] for Fish/Crab Tissue for an Adult Angler			
	Cancer PRGs (ng/g)			Non-cancer PRGs (ng/g)
	$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	
TCDD TEQ	0.000055	0.00055	0.0055	ND [2]
Total PCB	4.1	41	410	56
Chlordane	23	230	2,300	1,407
Methyl mercury	ND [3]			281

ng/g – nanograms per gram of sediment
ND – not determined.
[1] Assumes 40 eight-ounce fish or crab meals per year for 24 years.
[2] No toxicity values are available at this time.
[3] Classification - There is no quantitative estimate of carcinogenic risk from oral exposure.

Table 2-12: Summary of the PRGs Developed for Sediment

COPC	PRGs [1] for Sediment			
	Cancer PRGs (ng/g)			Non-cancer PRGs (ng/g)
	$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	
2,3,7,8-TCDD	0.00027	0.0027	0.027	ND [2]
Total PCB	1.03	10.3	103	14
Chlordane	1.2	12.0	119	72
Mercury	ND [3]			2,814

[1] Assumes 40 eight-ounce fish or crab meals per year for 24 years.
[2] No toxicity values are available at this time.
[3] Classification - There is no quantitative estimate of carcinogenic risk from oral exposure.

Table 2-13: Summary of Sediment PRGs for Ecological Receptors

Chemical	Units	Sediment PRGs		Lowest
		Benthos [1]	Wildlife [2]	
Inorganics				
Copper	ng/g	34,000	13,318	Wildlife PRG
Lead	ng/g	46,700	10,606	Wildlife PRG
Mercury	ng/g	150	37	Wildlife PRG
PAHs				
Low Molecular Weight PAHs	ng/g	552	-	NOAA ER-L
High Molecular Weight PAHs	ng/g	1700	-	NOAA ER-L
PCB Aroclors				

Chemical	Units	Sediment PRGs		Lowest
		Benthos [1]	Wildlife [2]	
Total PCBs	ng/g	22.7	365	NOAA ER-L
Pesticides/Herbicides				
DDx	ng/g	1.58	19	NOAA ER-L
Dieldrin	ng/g	0.02	271	NOAA ER-L
Dioxins/Furans				
TCDD TEQ [3]	ng/g	0.0032	0.0025	Wildlife PRG

[1] Benthos PRG derived from ER-L = Effects Range-Low from Long *et al.* (1995), except where noted.
[2] Derived as described in the FFS COPEC Screening Technical Memorandum (Appendix C of the FFS; Malcolm Pirnie, Inc., 2007b).
[3] Benthic benchmark for 2,3,7,8-TCDD derived by USFWS using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003); wildlife value from USEPA (1993).

Table 2-14: Summary of Fish Tissue PRGs for Ecological Receptors

Chemical	Units	Fish Tissue PRGs		Lowest
		Fish [1]	Wildlife [2]	
Inorganics				
Copper	ng/g	6.3	21,935	Fish
Lead	ng/g	88	700	Fish
Mercury	ng/g	19	40	Fish
PAHs				
Low Molecular Weight PAHs	ng/g	89	-	Fish
High Molecular Weight PAHs	ng/g	89	-	Fish
PCB Aroclors				
Total PCBs	ng/g	7.9	676	Fish
Pesticides/Herbicides				
DDx	ng/g	0.3	147	Fish
Dieldrin	ng/g	35	487	Fish
Dioxins/Furans				
TCDD TEQ [3]	ng/g	0.050	0.0007	Wildlife

[1] Based on critical body residuals as summarized in Appendix C of the FFS (Malcolm Pirnie, Inc., 2007b).
[2] Derived as described in the FFS COPEC Screening Technical Memorandum (Appendix C of the FFS; Malcolm Pirnie, Inc., 200b7); lowest of mammal and avian values.
[3] Low risk fish concentrations for 2,3,7,8-TCDD from USEPA (1993).

The COPC and COPEC concentrations known to exist in the surface sediments of the lower 8 miles are much greater than the PRGs listed in Table 2-10. For this reason a remedial strategy that can reduce the concentrations to at least the level of background is necessary to begin to achieve the RAOs. The lower 8 miles have been identified as a major source of contamination to the Lower Passaic River (Malcolm Pirnie, Inc., 2007a), and it has been determined that the remediation of this area (through the Source Control Early Action) would be capable of achieving acceptable risk reduction (Appendix C of the FFS; Malcolm Pirnie, Inc., 2007b).

The background levels for many of the contaminants pose unacceptable risks, in part resulting from continuing contributions from upstream sources. Thus, while the Source Control Early Action addresses the contaminated sediments of the lower eight miles of the Passaic River, a separate source control action is necessary above Dundee Dam to identify and reduce or eliminate those background sources. Such a separate action might include identifying facilities above the dam with on-going contributions to the Upper Passaic River, or conducting a track-down program where samplers are placed further and further upstream until contaminants are tracked back to specific industrial or municipal sources. Such sources would then be controlled through federal or State of New Jersey regulatory programs. In addition, it is important to note that if background concentrations were reduced through a source control program above the Dundee Dam, the relative contributions of the various sources to overall site risks will change; in such a situation, ecological risks may become more important in establishing remedial goals.

2.8 DESCRIPTION OF REMEDIAL ALTERNATIVES

Six active remedial alternatives for the Lower Passaic River Restoration Project are described below. The active remedial alternatives were developed to target the fine-grained sediment present in the Area of Focus by dredging, capping, or a combination of these options. The remedial alternatives and cost estimates were developed as part of the FFS (Malcolm Pirnie, Inc., 2007b).

Two dredged material management scenarios incorporating nearshore confined disposal facility (CDF) disposal were considered in developing the cost estimates. Dredged Material Management Scenario A assumes the all dredged material would be permanently disposed of in a CDF. Dredged Material Management Scenario B assumes that all dredged material would initially be placed in a CDF, but the volume stored above the original mudline grade (prior to excavation within the CDF footprint) would be dewatered and treated by an onsite thermal treatment facility. The volume to be thermally treated under Scenario B is up to approximately 1.7 million cubic yards (*in-situ*). When necessary to provide the required capacity, excavation below the mudline (within the footprint of the CDF) would be performed.

Alternative 1 – Removal of Fine-Grained Sediment from Area of Focus

Alternative 1 would use mechanical dredging to remove fine-grained sediment from the Area of Focus.

Within the horizontal limits of the federally authorized navigation channel, the depth of fine-grained sediment corresponds well with the depth of historical dredging. For this reason, the depth of dredging within these horizontal limits is assumed to be the historically constructed channel depth plus an additional three feet to account for historical overdredging (two feet) and dredging accuracy (one foot).

Outside of the horizontal limits of the federally authorized navigation channel, the depth of fine-grained sediment varies. Therefore, data from geotechnical cores and chemical cores were used to estimate the depth of the fine-grained sediment boundary at various locations in the river. The depth of dredging at each of these locations is the estimated depth of fine-grained sediment plus an additional one foot to account for dredging accuracy.

The objective of Alternative 1 is to remove as much of the fine-grained sediment as practicable, resulting in the exposure of the underlying sandy material. As soon as practicable after exposure of this sandy material, two feet of backfill material would be placed to mitigate residual contamination. The thickness of this backfill material would not be monitored or maintained following implementation.

The dredged material removed during implementation of Alternative 1 would be placed into a nearshore CDF. After the material is passively dewatered, it may either be removed from the CDF for thermal treatment, or it may be permanently capped in place.

After construction is completed, this alternative relies on institutional controls, such as fish consumption advisories, while MNR processes act to reduce the concentration of the remaining contamination until the Remedial Action Objectives are achieved. A long-term monitoring program would be implemented to verify that the river is responding with reduced contamination levels over the long term. A review of Site conditions would be conducted at five-year intervals, as required by CERCLA.

A portrayal of Alternative 1 is shown on Figure 2-20, and the costs and schedule for Alternative 1 are summarized in Table 2-15. Alternative 1 involves the removal of approximately 10,960,000 cubic yards (cy) of dredged material and the placement of approximately 2,100,000 cy of backfill material and 208,000 cy of mudflat reconstruction material.

Table 2-15: Summary of Costs and Construction Time for Alternative 1

Costs	DMM Scenario A	DMM Scenario B
Total Capital Costs:	$1,092,000,000	$1,092,000,000
Total DMM Costs:	$763,000,000	$1,085,000,000
Total O&M Costs:	$91,000,000	$95,000,000
Total Present Worth Costs (5% Rate over 30 Years):	$1,947,000,000	$2,272,000,000
Construction Time:	12 years	12 years

O&M – Operations and maintenance

Alternative 2 – Engineered Capping of Area of Focus

Alternative 2 would sequester the contaminated sediments in the Area of Focus under an engineered cap. Minimal removal of contaminated sediments, for the purposes of mudflat reconstruction and armor placement only, is assumed for Alternative 2.

The cap would be constructed of sand, stone, and mudflat reconstruction material. Over approximately 80 percent of the sediment surface area, the cap would be constructed of sand alone. In areas of unacceptable erosion, estimated to be approximately 20 percent of the river surface in Appendix G of the FFS (Malcolm Pirnie, Inc., 2007b), stone would be used as armor material. In select small areas of the river, existing mudflats would be reconstructed by removing 3 feet of contaminated sediment, placing 1.5 feet of sand as substrate, and placing 1 foot of mudflat reconstruction material.

It has been assumed that placement of sand material would be conducted using conventional methods, which would be capable of minimizing the amount of settlement of the sand material into the existing silt. Placement of armor material would be achieved using mechanical methods. Due to the proximity to shore, mudflat reconstruction material would likely be placed via mechanical equipment.

The thickness of the engineered cap would be monitored and maintained following implementation as part of the annual Post-Construction Monitoring Program.

Flood modeling as described in Appendix G of the FFS (Malcolm Pirnie, Inc., 2007b) has shown that pre-dredging prior to cap placement does not substantially reduce the total area flooded. Therefore, pre-dredging in areas to be capped has not been incorporated into Alternative 2.

The dredged material removed during implementation of Alternative 2 would be placed into a nearshore CDF. After the material is passively dewatered, it may either be removed from the CDF for thermal treatment, or it may be permanently capped in place.

After construction is completed, this alternative relies on institutional controls, such as fish consumption advisories and restrictions on activities that could compromise the integrity of the cap, while MRN processes act to reduce the concentration of the remaining contamination until the Remedial Action Objectives are achieved. A long-term monitoring program would be implemented to verify the integrity of the cap, ensure that the thickness of the cap is maintained and verify that the river is responding with reduced contamination levels over the long term. If any portion of the cap became eroded, it would require replacement. A review of Site conditions would be conducted at five-year intervals, as required by CERCLA.

A portrayal of Alternative 2 is shown on Figure 2-21, and the costs and schedule for Alternative 2 are summarized in Table 2-16. Alternative 2 involves the removal of approximately 1,142,000 cy of dredged material and the placement of approximately 3,151,000 cy of capping material, 623,000 cy of armor material, and 208,000 cy of mudflat reconstruction material.

Table 2-16: Summary of Costs and Construction Time for Alternative 2

Costs	DMM Scenario A	DMM Scenario B
Total Capital Costs:	$537,000,000	$537,000,000
Total DMM Costs:	$230,000,000	$477,000,000
Total O&M Costs:	$96,000,000	$97,000,000
Total Present Worth Costs (5% Rate over 30 Years):	$863,000,000	$1,111,000,000
Construction Time:	6 years	6 years

Alternative 3 – Engineered Capping of Area of Focus Following Reconstruction of Federally Authorized Navigation Channel

The dimensions of the federally authorized navigation channel are provided in Section 2.5.2.1 "Current Federally Authorized and Constructed Navigation Channel." Alternative 3 would use mechanical dredging to remove sediment from within the horizontal limits of the federally authorized navigation channel. The depth of dredging within these horizontal limits is assumed to be the historically constructed channel depth plus an additional three feet to account for historical overdredging (two feet) and dredging accuracy (one foot). The sediment surface between the bottom of the dredged channel and the existing sediment surface ("sideslope") would be constructed at a slope of 3 horizontal to 1 vertical (3H:1V).

After sediments are removed from the federally authorized navigation channel to the depth specified above, it is assumed that a minimal amount of fine-grained sediment would remain in the channel. Therefore, a two-foot backfill layer would be placed to mitigate remaining fine-grained sediment and dredging residuals. The thickness of this backfill material would not be monitored or maintained following implementation.

Outside of the horizontal limits of the federally authorized navigation channel, however, it is possible that additional, un-targeted contaminant inventory would remain in place. For this reason, it is assumed that an engineered cap would be placed on the sideslopes, as well as on the existing sediment surface between the channel and the shoreline ("shoal"). In areas of unacceptable erosion on the sideslopes and/or shoals, as identified in Appendix G of the FFS (Malcolm Pirnie, Inc., 2007b) stone would be used as armor material. The thickness of the engineered cap would be monitored and maintained following implementation as part of the annual Post-Construction Monitoring Program.

The dredged material removed during implementation of Alternative 3 would be placed into a nearshore CDF. After the material is passively dewatered, it may either be removed from the CDF for thermal treatment, or it may be permanently capped in place.

After construction is completed, this alternative relies on institutional controls, such as fish consumption advisories and restrictions on activities that could compromise the integrity of the cap, while MNR processes act to reduce the concentration of the remaining contamination until the Remedial Action Objectives are achieved. A long-term monitoring program would be implemented to verify the integrity of the cap, ensure that the thickness of the cap is maintained and verify that the river is responding with reduced contamination levels over the long term. If any portion of the cap became eroded, it would require replacement. A review of Site conditions would be conducted at five-year intervals, as required by CERCLA.

A portrayal of Alternative 3 is shown on Figure 2-22, and the costs and schedule for Alternative 3 are summarized in Table 2-17. Alternative 3 involves the removal of approximately 6,979,000 cy of dredged material and the placement of approximately 2,702,000 cy of backfill material, 52,000 cy of armor material, and 208,000 cy of mudflat reconstruction material.

Table 2-17: Summary of Costs and Construction Time for Alternative 3

Costs	DMM Scenario A	DMM Scenario B
Total Capital Costs:	$901,000,000	$901,000,000
Total DMM Costs:	$522,000,000	$847,000,000
Total O&M Costs:	$94,000,000	$97,000,000
Total Present Worth Costs (5% Rate over 30 Years):	$1,518,000,000	$1,845,000,000
Construction Time:	8 years	8 years

Alternative 4 – Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Current Usage

As described in the FFS (Malcolm Pirnie, Inc., 2007b), USACE-New York District has estimated the dimensions of the navigation channel necessary to accommodate current usage. Alternative 4 would use mechanical dredging to construct a channel of these dimensions, and subsequently place an engineered cap over the entire Area of Focus.

From RM0 to RM1.2, the depth of dredging within the horizontal limits of the federally authorized navigation channel is assumed to be the historically constructed channel depth (30 feet MLW) plus an additional three feet to account for historical overdredging (two feet) and dredging accuracy (one foot). The sideslope would be constructed at a slope of 3H:1V. After sediments are removed from the federally authorized navigation channel to the depth specified above, it is assumed that a minimal amount of fine grained sediment would remain in the channel. Therefore, a two-foot backfill layer would be placed to mitigate remaining fine grained sediment and dredging residuals. The thickness of this backfill material would not be monitored or maintained following implementation.

From RM1.2 to RM2.5, the depth of dredging within the horizontal limits of the federally authorized navigation channel is assumed to be the depth required by the design vessel (13 feet), plus an additional three feet for underkeel clearance, plus an additional nine feet to accommodate the necessary cap components that would be placed. The sideslope would be constructed at a slope of 3H:1V. Following removal to the depth described above, it is possible that additional, un-targeted contaminant inventory could remain in place. Therefore, an engineered cap would be placed on the channel bottom. The thickness of the engineered cap would be monitored and maintained following implementation as part of the annual Post-Construction Monitoring Program.

In the sideslope and shoal areas of RM0 to RM2.5, and throughout the rest of the Area of Focus from RM2.5 to RM8.3, it is likely that additional, un-targeted contaminant inventory would remain in place. Therefore, pre-dredging to accommodate an engineered cap would be necessary in these areas. In areas of unacceptable erosion, as identified in Appendix G of the FFS (Malcolm Pirnie, Inc., 2007b), stone would be used as armor material.

The dredged material removed during implementation of Alternative 4 would be placed into a nearshore CDF. After the material is passively dewatered, it may either be removed from the CDF for thermal treatment, or it may be permanently capped in place.

After construction is completed, this alternative relies on institutional controls, such as fish consumption advisories and restrictions on activities that could compromise the integrity of the cap, while MNR processes act to reduce the concentration of the remaining contamination until the Remedial Action Objectives are achieved. A long-term monitoring program would be implemented to verify the integrity of the cap, ensure that the thickness of the cap is maintained and verify that the river is responding with reduced contamination levels over the long term. If any portion of the cap became eroded, it would require replacement. A review of Site conditions would be conducted at five-year intervals, as required by CERCLA.

A portrayal of Alternative 4 is shown on Figure 2-23, and the costs and schedule for Alternative 4 are summarized in Table 2-18. Alternative 4 involves the removal of approximately 4,432,000 cy of dredged material and the placement of approximately 3,080,000 cy of capping material, 429,000 cy of armor material, and 208,000 cy of mudflat reconstruction material.

Table 2-18: Summary of Costs and Construction Time for Alternative 4

Costs	DMM Scenario A	DMM Scenario B
Total Capital Costs:	$754,000,000	$754,000,000
Total DMM Costs:	$418,000,000	$744,000,000
Total O&M Costs:	$95,000,000	$97,000,000
Total Present Worth Costs (5% Rate over 30 Years):	$1,267,000.000	$1,596,000,000
Construction Time:	6 years	6 years

Alternative 5 – Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Future Usage

As described in the FFS (Malcolm Pirnie, Inc., 2007b), the State of New Jersey has estimated the dimensions of the navigation channel necessary for future river traffic. Alternative 5 would use mechanical dredging to construct a channel of these dimensions, and place an engineered cap or backfill over the Area of Focus.

From RM0 to RM1.2, the depth of dredging within the horizontal limits of the federally authorized navigation channel is assumed to be the historically constructed channel depth (30 feet MLW) plus an additional three feet to account for historical overdredging (two feet) and dredging accuracy (one foot). The channel sides would be constructed at a slope of 3H:1V. After sediments are removed from the federally authorized navigation channel to the depth specified above, it is assumed that a minimal amount of fine grained sediment would remain in the channel. Therefore, a two foot backfill layer would be placed to mitigate remaining fine grained sediment and/or dredging residuals. The thickness of this backfill material would not be monitored or maintained following implementation.

From RM1.2 to RM2.5, the depth of dredging within the horizontal limits of the federally authorized navigation channel is assumed to be the depth required by the design vessel

(13 feet), plus an additional three feet for underkeel clearance to achieve the channel depth of 16 feet MLW, plus an additional nine feet to accommodate the necessary cap components that would be placed. The channel sides would be constructed at a slope of 3H:1V. Following removal to the depth described above, it is possible that additional, un-targeted contaminant inventory would remain in place. Therefore, an engineered cap would be placed on the channel bottom. The thickness of the engineered cap would be monitored and maintained following implementation as part of the annual Post-Construction Monitoring Program.

From RM2.5 to RM3.6, the depth of dredging within the horizontal limits of the federally authorized navigation channel is assumed to be the historically constructed channel depth (20 feet MLW) plus an additional three feet to account for historical overdredging (two feet) and dredging accuracy (one foot). The sideslope would be constructed at a slope of 3H:1V. After sediments are removed from the federally authorized navigation channel to the depth specified above, it is assumed that a minimal amount of fine grained sediment would remain in the channel. Therefore, a two-foot backfill layer would be placed to mitigate remaining fine grained sediment and dredging residuals. The thickness of this backfill material would not be monitored or maintained following implementation.

From RM3.6 to RM8.3, the depth of dredging within the horizontal limits of the federally authorized navigation channel is assumed to be the depth required by the design vessel (seven feet), plus an additional three feet for underkeel clearance, plus an additional nine feet to accommodate the necessary cap components that would be placed. This alternative will require sediment removal to 19 feet MLW. However, the depth of the authorized historical channel from RM8.1 to RM8.3 is 10 feet. An addition of three feet to the authorized depth to account for historical overdredging (two feet) and dredging accuracy (one foot) result in a historical channel depth of 13 feet MLW (not 19 feet MLW). Since dredge depth is limited to the historical channel depth, it is assumed that sediment will be removed to a depth of 13 feet MLW from RM8.1 to RM8.3. Following removal to the depth described above (*i.e.*, 19 feet MLW from RM3.6 to RM8.1 and 13 feet from RM8.1 to RM8.3), it is possible that additional, un-targeted contaminant inventory would remain in place from RM3.6 to RM4.6; however, it is assumed that minimal fine-grained sediment would remain in the channel from RM4.6 to RM8.3. Therefore, an engineered cap would be placed on the channel bottom from RM3.6 to RM4.6 and a two foot backfill layer would be placed to mitigate for any remaining fine-grained sediment and/or dredging residuals from RM4.6 to RM8.3. The side slope would be constructed at a slope of 3H:1V. The thickness of the engineered cap would be monitored and maintained following implementation as part of the annual Post-Construction Monitoring Program, but the backfill layer would not be maintained.

In the sideslope and shoal areas of RM0 to RM8.3, it is likely that additional, un-targeted contaminant inventory would remain in place. For this reason, it is assumed that an engineered cap would be placed in these areas. In areas of unacceptable erosion, as identified in Appendix G “Cap Erosion and Flood Modeling,” stone would be used as armor material. The thickness of the engineered cap would be monitored and maintained following implementation as part of the annual Post-Construction Monitoring Program.

Flood modeling as described in Appendix G of the FFS (Malcolm Pirnie, Inc., 2007b), has shown that pre-dredging prior to cap placement would reduce the total area flooded to below the acreage flooded under the base case. Therefore, pre-dredging in areas to be capped has been incorporated into Alternative 5.

The dredged material removed during implementation of Alternative 5 would be placed into a nearshore CDF. After the material is passively dewatered, it may either be removed from the CDF for thermal treatment, or it may be permanently capped in place.

After construction is completed, this alternative relies on institutional controls, such as fish consumption advisories and restrictions on activities that could compromise the integrity of the cap, while MNR processes act to reduce the concentration of the remaining contamination until the Remedial Action Objectives are achieved. A long-term monitoring program would be implemented to verify the integrity of the cap, ensure that the thickness of the cap is maintained and verify that the river is responding with reduced contamination levels over the long term. If any portion of the cap became eroded, it would require replacement. A review of Site conditions would be conducted at five-year intervals, as required by CERCLA.

A portrayal of Alternative 5 is shown on Figure 2-24, and the costs and schedule for Alternative 5 are summarized in Table 2-19. Alternative 5 involves the removal of approximately 6,148,000 cy of dredged material and the placement of approximately 2,453,000 cy of capping material, 95,000 cy of armor material, and 208,000 cy of mudflat reconstruction material.

Table 2-19: Summary of Costs and Construction Time for Alternative 5

Costs	DMM Scenario A	DMM Scenario B
Total Capital Costs:	$839,000,000	$839,000,000
Total DMM Costs:	$489,000,000	$814,000,000
Total O&M Costs:	$93,000,000	$96,000,000
Total Present Worth Costs (5% Rate over 30 Years):	$1,421,000,000	$1,749,000,000
Construction Time:	7 years	7 years

Alternative 6 – Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Future Usage and Removal of Fine-Grained Sediment from Primary Inventory Zone and Primary Erosional Zone

A portrayal of Alternative 6 is identical to that of Alternative 5, with the exception that, in the Primary Erosional Zone and the Primary Inventory Zone, the depth of dredging is assumed to be the estimated depth of fine grained sediment plus an additional one foot to account for dredging accuracy.

After construction is completed, this alternative relies on institutional controls, such as fish consumption advisories and restrictions on activities that could compromise the integrity of the cap, while MNR processes act to reduce the concentration of the remaining contamination until the Remedial Action Objectives are achieved. A long-term monitoring program would be implemented to verify the integrity of the cap, ensure that the thickness of the cap is maintained and verify that the river is responding with reduced contamination levels over the long term. If any portion of the cap became eroded, it would require replacement. A review of Site conditions would be conducted at five-year intervals, as required by CERCLA.

A portrayal of Alternative 6 is shown on Figure 2-25, and the costs and schedule for Alternative 6 are summarized in Table 2-20. Alternative 6 involves the removal of approximately 7,010,000 cy of dredged material and the placement of approximately 2,368,000 cy of capping material, 49,000 cy of armor material, and 208,000 cy of mudflat reconstruction material.

Table 2-20: Summary of Costs and Construction Time for Alternative 6

Costs	DMM Scenario A	DMM Scenario B
Total Capital Costs:	$879,000,000	$879,000,000
Total DMM Costs:	$524,000,000	$849,000,000
Total O&M Costs:	$93,000,000	$96,000,000
Total Present Worth Costs (5% Rate over 30 Years):	$1,496,000,000	$1,824,000,000
Construction Time:	8 years	8 years

2.8.1 Compliance of Monitored Natural Recovery with USEPA Policy

The MNR component of the active alternatives was developed in accordance with *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (USEPA, 2005). A detailed understanding of the natural processes that are affecting sediment and contaminants at the site was developed in the Draft Geochemical Evaluation (Step 2)

(Malcolm Pirnie, Inc., 2006c), and a tool to predict future effects of these natural processes was developed in the EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b). Significant ongoing contaminant sources have been identified in the EMBM, and the USEPA plans to initiate work to identify and characterize sources of contamination located upstream of Dundee Dam (Malcolm Pirnie, Inc., 2007b). Detailed human health and ecological risk assessments have been performed (Appendix C of the FFS; Malcolm Pirnie, Inc., 2007b) to address ongoing risks and exposure control. Monitoring of natural processes and contaminant concentrations to assess natural recovery can be performed through sediment and biological tissue sampling programs.

The reduction of contaminant concentrations through MNR in the Lower Passaic River will rely on two major processes:

- Burial and/or mixing-in-place of contaminated sediment with cleaner sediment.

- Dispersion of particle-bound contaminants or diffusive or advective transport of contaminants to the water column.

Contaminant reduction through transformation processes (*e.g.*, biodegradation, abiotic transformations) and sorption or other binding processes will not be relied upon.

2.9 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Nine criteria are used to address the CERCLA requirements for analysis of remedial alternatives. The first two criteria are threshold criteria that must be met by each alternative. The next five criteria are the primary balancing criteria upon which the analysis is based. The final two criteria, referred to as modifying criteria, are typically applied following the public comment period for the Proposed Plan to evaluate state and community acceptance. The following sections present a detailed analysis of the individual remedial alternatives in reference to the evaluation criteria and a comparative analysis to evaluate the relative performance of remedial alternatives in relation to each evaluation criterion. The comparative analysis of remedial alternatives is summarized in Table 2-21 (a summary of the detailed analysis) and Table 2-22 (a summary of quantitative estimates for each alternative).

2.9.1 Overall Protection of Human Health and the Environment

Based on the risk evaluations summarized in Section 2.6 "Summary of Site Risks," existing conditions present unacceptable risks to human health and the environment. Active remediation of the Area of Focus reduces the COPC and COPEC concentrations in the surface sediments to within the background concentrations that are currently introduced to the Lower Passaic River from the Upper Passaic River, reduces the human health risk by 95 to 98 percent (fish versus crab consumption), and reduces the ecological hazard by 78 to 98 percent (species dependent), which meets the RAO. Based on prediction of future surface concentrations generated using the EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b), active remediation of the Area of Focus followed by MNR will achieve thresholds for 2,3,7,8-TCDD, which is responsible for about 65 percent of the risk. The reduction of other COPCs and COPECs is also achieved by active remediation of the Area of Focus. For this reason, the six active alternatives are considered protective of human health and the environment.

The 17-mile Study will evaluate remaining threats to human health and the environment in the Study Area and the timeframe to achieve RAOs using a fate, transport, and bioaccumulation model that is currently in development and not available for this Briefing Package.

2.9.2 Compliance with ARARs

Each active remedial alternative would be designed and constructed in compliance with the ARARs identified, except those which may be waived by the Regional Administrator in accordance with CERCLA Section 121(d).

The active alternatives are comprised of the following seven elements:

- Pre-Construction Activities
- Construction and Operation of a Support Area
- Dredging
- Capping
- CDF Construction and Operation
- Thermal Treatment
- Wastewater Treatment and Discharge

Table 2-23 lists the ARARs and their statutory or regulatory citations for each of these seven elements. This table also presents the rationale for the parts of each element of the remediation process that will fall under each ARAR.

2.9.3 Long-Term Effectiveness and Permanence

2.9.3.1 Magnitude of Residual Risk

The overall risk reduction achieved by each alternative has been evaluated based on the future surface concentrations predicted by the EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b). Over the time frame considered (30 years after remedial actions are complete), the active remedial alternatives reduce cancer risk for the combined child/adult receptor to 5×10^{-4} from fish consumption and to 4×10^{-4} from crab consumption. In addition, the non-cancer health HI for the adult receptor is reduced from 64 to 4.7 from fish consumption and from 86 to 3.5 from crab consumption. The non-cancer health HI for the child receptor is reduced from 99 to 22 from fish consumption and from 140 to 19 from crab consumption. The ecological hazards present at the site are reduced from 339 to 5.8 for the mink receptor and from 49 to 1.8 for the heron receptor (Malcolm Pirnie, Inc., 2007b). The risk reduction for each of the six active alternatives is equivalent at the level of precision achieved by the calculations presented in the EMBM, and no additional risk reduction is estimated to result from additional removal of contaminated sediment, as each alternative places a sand layer and achieves equivalent surface concentrations following active remediation. In addition, all of the active remedial alternatives rely on institutional controls to maintain protectiveness following remedy construction, while natural recovery processes continue to reduce surface concentrations in the Area of Focus to reduce risks to within the risk range. Also, separate source control actions above Dundee Dam, when implemented, will accelerate the time frame within which the active alternatives achieve risk ranges.

2.9.3.2 Adequacy and Reliability of Controls

Among the six remedial alternatives, there is not a great difference in the degree of adequacy of controls achieved. The reliability of both dredging and engineered caps depends upon proper design and implementation, while the reliability of capping also depends on the consistency and sufficiency of future maintenance.

Alternative 1 relies exclusively on placement of a backfill layer to provide a measure of control in the event that residual contamination poses health risks. This alternative does not include an engineered cap, because the intent is for the contaminated fine-grained sediment to be removed with the assumption that the underlying less-contaminated sand material will not erode to any significant extent. The backfill layer is not intended to be maintained, in contrast to the engineered cap in Alternative 2 whose thickness is maintained in the long term in order to ensure protectiveness of contaminant inventory left underneath.

Alternatives 3, 4, 5, and 6 rely on varying combinations of backfill and engineered cap, depending on the amount of contaminated inventory left after dredging. Of these four alternatives, Alternative 3 proposes removing the most fine-grained sediment down to the underlying sandy layer, while Alternative 4 proposes leaving behind the most contaminant inventory, so that Alternative 3 relies most heavily on backfill and Alternative 4 relies most on engineered capping. Institutional controls would be required to ensure that engineered cap layers are not disturbed by human activities.

In all active alternatives, the use of a CDF for storage or final disposal, if constructed properly (*e.g.*, with low permeability barriers and with effluent controls) is considered to be adequate and reliable based on the preliminary identification of potential sites and the use of similar facilities in other projects.

Established thermal destruction facilities have sufficient prior experience with treatment of hazardous materials and disposal of treatment residuals to predict a high level of reliability. Newly constructed facilities would require a prove-out period to demonstrate ability to reduce contaminant concentrations resulting from implementation of any active alternative to acceptable levels reliably and to ensure air emissions are within acceptable ranges.

2.9.4 Reduction of Toxicity, Mobility, or Volume through Treatment

2.9.4.1 Treatment Processes Used and Materials Treated

Among the six remedial alternatives, the treatment processes used on Lower Passaic River sediments do not vary.

The extent to which each treatment process is used varies based on the mass and volume of sediment removal. For example, Alternative 2 removes the least amount of sediment, while Alternative 1 removes the most. After removal, thermal treatment of dredged sediment, if used, will irreversibly destroy organic contaminants in the treated sediment, while non-volatile metals will be fused and bound into the residual matrix. Volatile metals will be released from the sediment matrix and captured during control of the off-gas emissions. In addition, water treatment process associated with dewatering operations will reduce the toxicity, mobility, and volume of contaminants present in process water.

2.9.4.2 Amount of Hazardous Material Destroyed or Treated

Among the six remedial alternatives, the amount of contaminated Lower Passaic River sediment removed and treated varies based on the depth and extent of dredging. The estimates of removal volume are presented in Table 2-22.

2.9.4.3 Degree of Expected Reductions in Toxicity, Mobility, and Volume

The six remedial alternatives vary slightly in their expected degrees of reduction in toxicity, mobility, and volume.

Alternative 1 involves removal of all fine-grained sediment. Alternatives 2-6 involve some removal of sediments before placement of a cap and armor. Each of these alternatives would, to some degree, reduce the volume of contaminated sediment in the Lower Passaic River by removal and subsequent treatment, if dredged material management Scenario B were selected. The degree of volume reduction varies based on the depth and extent of dredging. The type of treatment specified for the removed sediment dictates the degree of reductions in toxicity, mobility, and volume. Thermal treatment would be expected to achieve approximately 99.9999 percent reduction in organic contaminants. Thermal treatment residuals could be disposed in a secure landfill or CDF. Material disposed in a CDF would not be treated prior to placement, but the mobility of contaminants in the material would be reduced. Disposal in a CDF would not satisfy the CERCLA statutory preference for treatment.

Alternatives 2-6 rely on capping to sequester contaminated sediments. The cap reduces the mobility of contaminants, thus reducing the transport to Newark Bay and the New York-New Jersey Harbor Estuary. Capping does not satisfy the CERCLA statutory preference for treatment. In addition, there is no reduction in the toxicity or volume of the contaminants under the cap.

2.9.4.4 Type and Quantity of Residuals Remaining after Treatment

The six remedial alternatives vary in the quantity of residuals generated based on the degree of sediment removal.

If sediment removal is followed by dewatering and water treatment, residuals such as flocculation sludge and filter sands would be generated. The quantities of these residuals would depend upon the sediment volumes that are removed. In addition, alternatives involving sediment dewatering may generate debris such as rocks, wood, and a variety of navigational and urban refuse that would be unable to pass through the dewatering treatment train; these materials would need to be managed as waste or recycled.

Thermal destruction would irreversibly destroy contaminants in the treated sediment. Thermal treatment residuals could be disposed in a secure landfill or CDF or be used beneficially as a product.

2.9.5 Short-Term Effectiveness

The six remedial alternatives vary slightly in short term effectiveness, as discussed below.

2.9.5.1 Protection of the Community during Remedial Action

Implementation of any active remedial alternative would result in impacts to the community (*e.g.*, noise, lights, and traffic) and could potentially require the processing, storage, transportation, and disposal of contaminated sediment near the Lower Passaic

River. Engineering controls would be in place to reduce the potential for exposure of the community to contaminants.

The placement of cap materials would likely result in a lesser degree of resuspension than dredging of contaminated sediment (USEPA, 2005). The overall duration during which the community would be impacted is greater for alternatives which remove a greater volume of material (*e.g.*, Alternative 1 would impact the community for a longer period of time than Alternative 2).

2.9.5.2 Protection of Workers during Remedial Action

The implementation of any active remedial alternative would potentially expose workers to contaminated sediment; however, dredging activities could result in a higher likelihood of exposure via direct contact, ingestion, and inhalation of contaminants in sediments and surface water than would placement of capping materials. The overall time during which workers would require protection is greater for alternatives which remove a greater volume of material.

2.9.5.3 Environmental Impacts

Alternatives which involve dredging of larger quantities of material require longer project durations, and potentially present incrementally greater potential for increased exposure of the community to dredged material. This potential for exposure can be reduced with the proper engineering controls, health and safety approaches, and design considerations.

In addition, the short term environmental impacts associated with resuspension of contaminated sediment would likely be incrementally greater for alternatives involving greater volumes of removal.

The existing habitat present in the Area of Focus would be impacted by any active remediation alternative. In addition, resuspension associated with cap placement or dredging activities could result in the transport of contaminated sediments and subsequent impact to adjacent areas. The placement of cap materials would likely result in a lesser degree of contaminant resuspension than dredging of contaminated sediment.

All remedial alternatives would involve the placement of clean material over existing sediment and reconstruction of mudflat areas impacted by remedial activities. In areas where armor is placed, benthic recolonization could occur, provided that silt or other benthic habitat material is subsequently deposited via natural processes. The construction of a CDF would constitute a permanent impact to habitat, and would require mitigation.

2.9.5.4 Time until Remedial Action Objectives are Achieved

The six remedial alternatives vary slightly in duration of implementation, as each alternative contains similar components including pre-design activities, design, mobilization, dredging, capping or backfilling, and demobilization. Following implementation, trends in surface sediment concentrations for each alternative are also comparable, as the post-implementation surface sediment concentrations achieved by each alternative are equivalent. These trends may be influenced by the depositional conditions achieved by each alternative.

Based on the relative contributions of the various sources of contamination considered in the EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b) and historical trends in sediment cores, post-remediation COPC and COPEC concentrations were calculated for the various remedial alternatives, based on the fact that remediation will reduce the resuspension flux of legacy sediments. Sediment resuspension as a source will be controlled by active remediation because each remedial alternative includes the placement of sand material in the lower eight miles of the river. This sand material will restrict the erosion and mixing of older, more contaminated sediments with the Lower Passaic River surface sediment. By controlling resuspension, future surface sediment concentrations were calculated for MNR (*i.e.*, no change in the resuspension source) and the active remedial alternatives. Refer to the EMBM for further detail on these calculations (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b).

Given the natural processes that are occurring in the river, the concentrations of most COPCs and COPECs will decline over time regardless of the method chosen for remediation. However, the EMBM concluded that active remediation has a significant effect on how quickly the recovery will occur as compared to MNR alone. For example, active remediation of the Area of Focus followed by MNR will achieve any threshold for 2,3,7,8-TCDD, which is responsible for about 65 percent of the risk, 40 years faster than it would be achieved by MNR alone. The reduction of other COPCs and COPECs is also accelerated by active remediation of the Area of Focus, except for chemicals (such as PAH) that have continuing sources external to the river. Table 2-24 gives the reduction of time in years for each COPC and COPEC for active remediation of the Area of Focus as compared to MNR.

Table 2-24: Time Difference Between MNR Scenario and Area of Focus Scenario (Malcolm Pirnie, Inc., 2007b)

Analyte	Time Difference (Years)
Mercury	10
Lead	5
Copper	5
Total Chlordane	-
DDE	15
DDD	15
DDT	15
Total DDT	15
Dieldrin	-
2,3,7,8-TCDD	40
PCDD/F TEQ	40
Total PCB	10
PCB TEQ Mammal	10
PCB TEQ Bird	10
PCB TEQ Fish	10
Total TEQ Mammal	40

Analyte	Time Difference (Years)
Total TEQ Bird	25
Total TEQ Fish	40
LMW PAH	-
HMW PAH	-

The symbol (-) represents no time difference.

The 17-mile Study will evaluate remaining threats to human health and the environment in the Study Area and the timeframe to achieve RAOs through a fate, transport, and bioaccumulation model that is currently in development and not available for this Briefing Package.

2.9.6 Implementability

2.9.6.1 Technical Feasibility

Alternatives 1-6 are all technically feasible. However, a major consideration in evaluating the feasibility of each alternative after implementation is the impact on flooding caused by changes in the bathymetry and bottom roughness of the river. Hydrodynamic modeling results presented in Appendix G of the FFS (Malcolm Pirnie, Inc., 2007b) indicate that Alternatives 2 and 4 have considerable flooding impacts; implementation of either alternative would increase flooding by 93 and 24 acres, respectively, beyond the amount predicted by modeling of existing conditions. Conversely, implementation of Alternative 5 would result in a slight reduction (by 17 acres) in flooding impact compared to existing conditions. Alternatives 1, 3, and 6 were not modeled, but are expected to show reductions similar to or greater than those predicted by modeling of Alternative 5, as similar sediment surface conditions but greater water depths are achieved by implementation of these alternatives.

2.9.6.2 Availability of Services and Materials

Each remedial alternative utilizes both dredging and capping or backfilling. Dredging and capping are both well developed technologies, and adequate, reliable, and available technology can be procured; there are no anticipated challenges to implementability.

Initial efforts have identified several potential land-based borrow sources in New Jersey collectively capable of supplying suitable capping material for the implementation of active alternatives; however, the capacity of individual sources has not been determined. Additionally, under the New York Harbor Deepening Program, several million cubic yards of sand will be removed from federal navigation channels between 2008 and 2011; although modeling results presented in Appendix G of the FFS (Malcolm Pirnie, Inc., 2007b) show that a cap cannot be constructed of this sand alone, this sand could be suitable for use in a filter layer or as backfill material. Furthermore, substantial quantities of rock will be removed from federal navigation channels, and could, if processed, be used as armor material. Significant cost savings would be realized if remediation activities could be coordinated with regional dredging programs (*e.g.*, utilization of sand or rock from the Harbor Deepening Program) to beneficially use this dredged material for backfill of dredged areas or construction of an engineered cap.

A preliminary review of the environs of the Lower Passaic River and Newark Bay suggests there are various nearshore areas amenable to the development of a CDF of sufficient size to accommodate the material to be removed from the Lower Passaic River as a consequence of any alternative. A thorough siting study would be required during the design phase.

Some portion of the contaminated sediment in the Lower Passaic River could be treated via thermal destruction methods. This feasibility analysis has identified potential thermal treatment options and vendors, and has identified no technical issues that would prevent construction of a new onsite facility.

2.9.6.3 Administrative Feasibility

The execution of any remedial activity in the Lower Passaic River would require significant coordination with and among federal, state, and local agencies. Alternatives 2-6, those involving capping, would require that issues pertaining to navigation be resolved prior to design of cap elevation, and that the creation of future habitat be discussed. Alternatives which incorporate greater quantities of dredging could potentially require incrementally more coordination due to the greater impact that dredged material management activities would have on the surrounding area and the need to identify suitable locations for a CDF for processing, storage, transportation, treatment, and disposal of dredged material.

2.9.7 Cost

The total cost for each alternative has been estimated based on capital costs as well as O&M costs. The six remedial alternatives range in cost from $0.9 billion to $2.3 billion (Malcolm Pirnie, Inc., 2007b).

2.9.7.1 Capital Costs

Capital costs have been estimated for activities pertaining to pre-construction investigations and design, mobilization/demobilization, site preparation, dredging and/or capping, and dredged material management. While capital costs for these activities vary predictably based on the extent of remediation conducted, the major drivers of capital cost are dredging and dredged material management. Alternatives which utilize dredging to remove a given volume of contaminated sediment are significantly more costly than alternatives which sequester the same volume of contaminated sediment by means of an engineered cap.

2.9.7.2 Operations and Maintenance Costs

Alternatives which employ an engineered cap over a greater area require more significant operations and maintenance costs. Monitoring of cap thickness and replenishment could be required, to some extent, in perpetuity. The extent of monitoring and maintenance, and therefore the total present worth of O&M costs, would depend on the time needed to verify the long term stability of the cap and the absence of significant contaminant fluxes through the cap. The cost estimates generated during this feasibility analysis have been based on a maintenance period of thirty years; however, a longer timeframe may apply for cap maintenance.

Finally, while operations and maintenance costs are higher for alternatives which utilize an engineered cap, the capital costs associated with dredged material management drive the total cost of alternatives which involve greater quantities of dredging. Alternatives involving capping achieve the same mass remediation and risk reduction as alternatives involving greater quantities of dredging for significantly lower total cost; however, the reliability of capping depends on the consistency and sufficiency of future maintenance activities.

2.9.8 Support Agency Acceptance

USEPA will offer a position on the preferred remedy after the Briefing Package and other project documents have been reviewed by the NRRB and USEPA's OSRTI Sediment Team.

State acceptance is not addressed in this document, but will be addressed in the ROD. It is important to note that NJDOT is the WRDA non-federal sponsor and NJDEP in a Trustee for the site; both are agency partners participating in the Study. As such, input from the State of New Jersey was sought and considered throughout the development of the FFS.

2.9.9 Community Acceptance

Community acceptance of the preferred remedy will be assessed in the ROD once public comments received on the FFS and proposed plan have been received. Input from the public and interested stakeholders, including the partner agencies, was sought and considered throughout the development of the FFS. This occurred through various technical workgroup sessions organized and hosted by the USEPA, through publication of information on the project website (www.ourPassaic.org), publication of information to interested members of the public in the form of ListServ notices, and other community involvement activities. A municipalities workshop was held in April 2007 to share project information and address community-specific concerns. Municipalities that participated in the workshop include Bayonne, Bloomfield, Clifton, Elizabeth, Garfield, Harrison, Newark, Nutley, and Rutherford. See Section 3.2 "Involve the Community Early and Often" for more information on community involvement activities.

2.10 PRINCIPAL THREAT WASTE

Not applicable.

2.11 PREFERRED REMEDIAL ALTERNATIVE

Not addressed.

2.12 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Chemical-specific, location-specific, and action-specific ARARs and "To Be Considered" Information (TBCs) are considered in the development and evaluation of remedial alternatives (Malcolm Pirnie, Inc., 2007b). When an alternative is selected, it must be able to fulfill the requirements of all ARARs (or a waiver must be justified). The ARARs and TBCs presented in this section apply to all of the remedial alternatives.

Table 2-23 provides a compilation of the ARARs identified for the FFS in consultation with the partner agencies, including statutory or regulatory citations for each ARAR. The ARARs are listed according to their applicability to each the seven elements of the Source Control Early Action (see Section 2.9.2 "Compliance with ARARs").

No ARARs were identified as drivers for the preferred remedy. ARARs drive the methods by which the remediation will be performed, but they do not drive the need for the remediation itself.

2.12.1 Chemical-Specific ARARs and TBCs

Chemical-specific ARARs and TBCs define concentration limits or other chemical levels for environmental media. Based on the RAOs for the Source Control Early Action FFS, only requirements for sediment are considered here. There are no ARARs for sediments.

A broad universe of potential chemical-specific TBCs was initially identified from criteria developed by other USEPA regions and a variety of other agencies (Appendix B of the FFS; Malcolm Pirnie, Inc., 2007b). PRGs were developed for the FFS; these PRGs, while not ARARs, are concentration limits that have been developed specifically for the Source Control Early Action based on site-specific RBCs. They are thus considered to be more appropriate benchmarks for Early Action at the site than any of the initially identified chemical-specific TBCs. As a result, all of the potential chemical-specific TBCs were screened from consideration as viable criteria for the Source Control Early Action.

2.12.2 Location-Specific ARARs and TBCs

The following location-specific ARARs were identified for the FFS:

- Endangered Species Act, 16 United States Code (U.S.C.) §1536; 50 Code of Federal Regulations (CFR) §402 Subpart B: Broad protection is provided for species of fish, wildlife, and plants that are listed as threatened or endangered in the United States or elsewhere.

- Federal Consistency Determination, 15 CFR § 930.36: The Federal Consistency Determination requires that federal agencies review their activities to determine whether such activities will be undertaken in a manner consistent to the maximum extent practicable with the enforceable policies of approved management programs.

- Freshwater Wetlands Protection Act Rules, New Jersey Administrative Code (N.J.A.C.) 7:7A-4.3: The Act regulates activities in freshwater wetlands, such as excavation, drainage, discharge of material, driving pilings, placing obstructions to flow, and destruction of plant life. The process for delineating a wetland and determining the width of the transition zone is specified, and wetland mitigation requirements are presented.

- National Historic Preservation Act (NHPA), 16 U.S.C. §470 et seq.; 36 CFR. Part 800: The NHPA requires consultation to identify historic properties potentially affected by federal activities and to assess the effects and to seek ways to avoid, minimize or mitigate any adverse impacts to those identified properties.

- Soil Erosion and Sediment Control Act regulations, N.J.A.C. 7:13-3.3: These regulations require controls for soil erosion and sediment prior to commencing any land development projects.

- Flood Hazard Control Act, New Jersey Statues Annotated (N.J.S.A.) 15:16A-50, et seq.: These regulations cover stream encroachment activities and development in floodways and flood fringes. Designs must prevent obstruction of flow or change in flow velocity in the case of a flood. Evaluations are ongoing to determine the applicability of these regulations.

The following location-specific TBC was identified for the FFS:

- NJDEP Soil Cleanup Criteria. [Contaminant Values for Residential Direct Contact Soil Cleanup Criteria, Non- Residential Direct Contact Soil Cleanup Criteria, and Impact to Ground Water Soil Cleanup Criteria; last revised May 12, 1999 (Note that NJDEP proposed new Soil Cleanup Criteria in May 2007; the final rule is planned to be promulgated after a public comment period ending July 27, 2007.)] The NJDEP soil cleanup criteria will be utilized for determining the appropriateness of using dredged sediments, or treated dredged sediments, for other beneficial land application uses within the State of New Jersey.

2.12.3 Action-Specific ARARs and TBCs

The following action-specific ARARs are identified for the FFS:

- Rivers and Harbors Act, 33 U.S.C. § 403: Activities that could impede navigation and commerce are prohibited without authorization from the Secretary of the Army. Such activities include obstruction or alteration of any navigable waterway, building of bulkheads outside harbor lines and any excavation or fill in navigable waters. In accordance with CERCLA Section 121(e)(1), no federal, state, or local permits are required for remedial actions that are conducted entirely on site, although remedial actions must comply with the substantive requirements of the Rivers and Harbors Act.

- Section 404 of the Clean Water Act (CWA), 40 CFR Parts 321, 322, and 323: The CWA includes requirements for the discharge of dredged or fill material into navigable waters of the United States. The Act also regulates the construction of any structure in navigable waters.

- RCRA, 40 CFR. § 261, 262, 264, 265, and 268: Dredged material may be subject to RCRA regulations if it contains a listed waste, or if it displays a hazardous waste characteristic based on the TCLP test. RCRA regulations may potentially be ARARs for the storage, treatment, and disposal of dredged material unless an exemption applies. If dredged material is removed but replaced in water within the Area of Contamination, which for this FFS includes the Lower Passaic River, Newark Bay and areal extent of contamination, RCRA land disposal regulations (LDR) are not triggered.

- Toxic Substances Control Act (TSCA), 40 CFR. § 761: TSCA regulates PCBs from manufacture to disposal. Remediation of sediments with PCB concentrations greater than 50 milligrams per kilogram of sediment or part per million is considered PCB waste remediation and is controlled under TSCA.

- Hazardous Materials Transportation Act, 49 CFR. § 107, 171, 172 and potentially 174, 176, or 177: United States Department of Transportation rules apply to the transportation of hazardous materials, and include the procedures for the packaging, labeling, manifesting, and transporting of hazardous materials.

- Stormwater Management Rules, N.J.A.C. 7:8-2.2 and Subchapter 5: These regulations establish the design and performance standards for stormwater management measures.

- Water Quality Certification, Section 401 of the CWA, 33 U.S.C § 1341: The CWA requires that applications for permits and licenses for any activity resulting in a discharge to navigable water include certification that the discharge will comply with applicable water quality and effluent standards. In accordance with CERCLA Section 121(e)(1), no federal, state, or local permits are required for remedial actions that are conducted entirely on site, although remedial actions must comply with the substantive requirements of CWA Section 401.

- New Jersey Pollutant Discharge Elimination System (NJPDES) Rules, N.J.A.C. 7:14A, (Subchapters 4.4, 5.3, 6.2, 11.2, 12.2, 13, 21.2 and Appendix B of chapter 12): This chapter regulates the direct and indirect discharge of pollutants to the surface water and ground water of New Jersey. It presents a list of effluent standards for site remediation projects, and includes rules for land application permits, residual transfer stations, and stormwater discharge information. In accordance with CERCLA Section 121(e)(1), no federal, state, or local permits are required for remedial actions that are conducted entirely on site, although remedial actions must comply with the substantive requirements of the NJPDES rules.

- New Jersey Technical Requirements for Site Remediation, N.J.A.C 7:26E-1.13, -2.1, -2.2, -3.4, -3.8, -3.11, -4.5 and -4.7: These regulations identify the minimum technical requirements that must be followed in the investigation and remediation of any contaminated sites in New Jersey. Both numeric and narrative standards for remediation of groundwater and surface water are listed.

- Federal/State Pretreatment Standards, 40 CFR. § 403, and more stringent requirements enacted by State or local law: These standards provide pretreatment criteria that waste streams must meet prior to discharge to Publicly Owned Treatment Works (POTW).

- National Ambient Air Quality Standards (40 CFR. § 50): The Clean Air Act requires USEPA to set standards for pollutants considered harmful to public health and the environment. Standards are established for six primary and secondary pollutants.

- New Jersey Air Pollution Control Rules, N.J.A.C. 7:27: The chapter governs emissions that introduce contaminants into the ambient atmosphere for a variety of substances and from a variety of sources.

2.13 TECHNICAL AND POLICY ISSUES

Technical and policy issues associated with the selection and implementation of the preferred remedy are discussed below.

2.13.1.1 Determining Future Navigational Requirements

The remedial alternatives presented in the FFS (Malcolm Pirnie, Inc., 2007b) incorporate three options for the reconstruction of the navigation channel in the Lower Passaic River. Alternative 3 allows for the reconstruction of the federally authorized navigation channel, which would be the deepest channel compared to those incorporated in the other alternatives. Alternative 4 allows for the shallowest channel, the reconstruction of the navigation channel to accommodate current usage. Current usage of the navigation channel is described in USACE's Navigation Analysis (Appendix F of the FFS; Malcolm Pirnie, Inc., 2007b). Alternatives 5 and 6 incorporate the reconstruction of the navigation channel to accommodate future use, which is discussed in a memorandum prepared by the NJDOT (Appendix F of the FFS; Malcolm Pirnie, Inc., 2007b). Depths of the federally authorized navigation channel and recommended minimum depths to accommodate current and future use are discussed in Sections 2.5.2.1 "Current Federally Authorized and Constructed Navigation Channel," 2.5.2.2 "Navigational Channel Dimensions to Accommodate Current Surface Water Uses," and 2.5.2.3 "Navigational Channel Depths to Accommodate Reasonably Anticipated Future Surface Water Uses," respectively.

Determining which navigational use scenario will meet the needs of federal and state agencies as well as local governments and communities in the Study Area represents a policy issue with respect to the implementation of the preferred remedy. It is important the action. It is likely that future navigational use needs will need to be more fully justified, which may require the integration of municipal master plans.

2.13.1.2 CDF Siting

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predecisional -deliberative Construction of a CDF would require containment measures such as sheet-piling. The CDF could be used for storage and passive dewatering of dredged sediment. A leachate collection system could be constructed to collect and channel effluent to a treatment system. As a final use, the dewatered sediment in the CDF could be removed for thermal treatment, or it could be permanently capped to create land for a beneficial use such as a park or development. One advantage of using a nearshore CDF for temporary storage is that a smaller thermal treatment plant could be constructed at a lower capital cost and sediment could be treated over a longer time.

predecisional -deliberative

predecisional -deliberative Dredged Material Management Scenario A assumes that all dredged material would be permanently disposed of in a CDF. Dredged Material Management Scenario B assumes that all dredged material would initially be placed in a CDF, but the volume stored above the original mudline grade (prior to excavation within the CDF footprint), would be dewatered and treated by an onsite thermal treatment facility. The volume to be thermally treated under Scenario B is up to approximately 1.7 million cubic yards (*in-situ*). If necessary at a particular location when selected, excavation below the mudline (within the footprint of the CDF) would be performed to provide the required capacity.

Technical issues related to the siting of a CDF include the following:

- The need for an extensive data collection program to identify and evaluate potential sites for the CDF; the program would include evaluations of site geology, evaluations of local community needs, and other relevant analyses.

- The design and construction of the CDF, including containment measures.

- The potential design and construction of a thermal treatment facility.

Policy issues related to the siting of a CDF include the following:

- Determining whether local communities in the selected area for the CDF prefer the construction of a thermal treatment facility or the development of a park or other beneficial use at the CDF site at project completion.

- The role of recent precedent and flexibility for remedial purposes in determining State acceptance of a CDF or thermal treatment facility in the region.

2.13.1.3 Determining the Applicability of New Jersey Flooding Regulations

Determining the applicability of the New Jersey Flood Hazard Control Act to the Study Area constitutes a policy issue associated with the implementation of the preferred remedy. The Flood Hazard Control Act covers stream encroachment activities and development in floodways and flood fringes. The regulation requires that designs must prevent the obstruction of flow or a change in flow velocity in the case of a flood.

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predecisional -deliberative Baseline flooding, although likely based on historical rather than tial in the Area of Focus. predecisional -deliberative

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2.13.1.4 Restrictions on Dredging to Create Additional Berth Areas

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dredging to create berth areas after the cap and backfill layers have been placed in the river. Prior to implementation, it is recommended that the USEPA and NJDOT identify any needed berth areas and incorporate dredging of these areas into the Source Control Early Action. Dredging of these areas after implementation of the remedy risks enhanced recontamination of the capped surface over a large area due to resuspension of contaminated sediments from below the cap and subsequent tidal mixing. Dredging after capping has been completed would need to be conducted such that resuspension in the berth area is minimized or avoided. [This may be accomplished by completely surrounding the area to be dredged with sheet pile; however, the installation of sheet pile may create secondary effects such as the restriction of river flow and associated impacts to river flooding, as well as increased scouring of the cap (and possibly erosion of underlying legacy sediments) adjacent to the area to be dredged. An evaluation of these secondary effects would be required prior to dredging.] In addition, replacement of the engineered cap in the new berth area would be required. predecisional -deliberative

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2.14 COST INFORMATION

The total cost for each alternative has been estimated based on capital costs, dredged material management costs, and O&M costs, and are presented in Table 2-25. The actual costs will vary depending on the specifications contained in the detailed remedial design. Further, the actual costs will also vary because the cost estimates provided are developed conservatively and have an accuracy of +50 percent to -30 percent, in compliance with USEPA guidance (USEPA, 1988).

Table 2-25: Cost Estimates for Remedial Alternatives

Alternative	DMM Scenario	Total Capital Costs	Total DMM Costs	Annual O&M Costs	Total O&M Costs	Total Present Worth Costs
Alternative 1: Removal of Fine-Grained Sediment from Area of Focus	A	$1,092,000,000	$763,000,000	$5,950,000	$91,000,000	$1,947,000,000
	B	$1,092,000,000	$1,085,000,000	$6,160, 000	$95,000,000	$2,272,000,000
Alternative 2: Engineered Capping of Area of Focus	A	$537,000,000	$230,000,000	$6,260, 000	$96,000,000	$863,000,000
	B	$537,000,000	$477,000,000	$6,280, 000	$97,000,000	$1,111,000,000
Alternative 3: Engineered Capping of Area of Focus Following Remediation of Federally Authorized Navigation Channel	A	$901,000,000	$522,000,000	$6,120, 000	$94,000,000	$1,518,000,000
	B	$901,000,000	$847,000,000	$6,280, 000	$97,000,000	$1,845,000,000
Alternative 4: Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Current Usage	A	$754,000,000	$418,000,000	$6,160, 000	$95,000,000	$1,267,000,000
	B	$754,000,000	$744,000,000	$6,330, 000	$97,000,000	$1,596,000,000
Alternative 5: Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Future Usage	A	$839,000,000	$489,000,000	$6,060, 000	$93,000,000	$1,421,000,000
	B	$839,000,000	$814,000,000	$6,230, 000	$96,000,000	$1,749,000,000
Alternative 6: Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Future Usage and Removal of Fine-Grained Sediment from Primary Inventory Zone and Primary Erosional Zone	A	$879,000,000	$524,000,000	$6,050, 000	$93,000,000	$1,496,000,000
	B	$879,000,000	$849,000,000	$6,210, 000	$96,000,000	$1,824,000,000

2.14.1 Capital Costs

Capital costs have been estimated for pre-construction activities (includes investigation and design), mobilization/demobilization, dredging (not including dredged material management), and backfilling or capping. The capital costs also include an additional 8 percent of the cost of field activities for construction management services and an additional 20 percent for contingency. The major driver of capital costs is dredging. For a given volume, alternatives which utilize dredging are significantly more costly than alternatives which sequester it by means of an engineered cap.

2.14.2 Dredged Material Management Costs

DMM costs are considered for two dredged material management scenarios incorporating nearshore CDF. DMM Scenario A assumes that all dredged material would be permanently disposed of in a CDF, while DMM Scenario B assumes that the volume stored above the original mudline grade would be dewatered and treated by an onsite thermal treatment facility.

DMM costs have been estimated for site characterization, starter cell construction, sub-grade cell construction, CDF construction (includes CDF operation and closing costs), and on-site thermal treatment. The DMM costs also include an additional 8% of the cost of field activities for construction management services and an additional 20% for contingency. The major costs driver for DMM costs are the sub-grade cell construction, the treatment of water within the CDF and from sediment dewatering operations, mechanical sediment dewatering, and on-site thermal treatment. Alternatives with smaller dredging volumes are less costly than alternatives with higher dredging volumes since excavation below the mudline is not as deep. Also, DMM Scenario B is significantly more costly than DMM Scenario A, since no thermal treatment is required in DMM Scenario A.

2.14.3 Operations and Maintenance Costs

Annual O&M costs have been estimated for bathymetric surveys, surface sediment, water column and groundwater sampling and analysis, biological monitoring, habitat recolonization surveys, cap maintenance, and community outreach. The major cost drivers are surface sediment sampling and analysis, biological monitoring and cap maintenance. While surface sediment sampling and analysis and biological monitoring costs are high, they are equal for all alternatives; however, O&M costs due to cap maintenance vary from one alternative to another. Alternatives which employ an engineered cap over a greater area require more significant O&M costs. Based on USEPA guidance, costs are included for a period of thirty years of monitoring for each alternative (USEPA, 1988); however, a longer timeframe may apply for cap maintenance. The present-worth of the annual O&M costs (total O&M costs) were calculated using a discount rate of 5 percent and a 30-year time interval.

Finally, while O&M costs are higher for alternatives which utilize an engineered cap, the DMM costs drive the total cost of alternatives which involve greater quantities of dredging. Alternatives involving capping achieve the same mass remediation and risk reduction as alternatives involving greater quantities of dredging for significantly lower total cost.

Because these alternatives would result in some contaminants remaining on-site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments.

2.15 LETTERS FROM STAKEHOLDERS AND STATE

To be addressed.

3.0 CSTAG CONSIDERATION MEMORANDUM

As a Tier 2 site, remedy selection rationale for the Lower Passaic River must be reviewed by the Contaminated Sediments Technical Advisory Group (CSTAG). This section presents an evaluation of the Source Control Early Action as required for CSTAG consideration using the 11 Risk Management Principles identified by USEPA in OSWER Directive 9285.6-08 (USEPA, 2002a), which is also included as Appendix A of the Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA, 2005). Each subsection below provides a discussion addressing consistency of the remedy selection with one of the 11 principles, presented in the order they are considered in the Directive.

3.1 CONTROL SOURCES EARLY

During the course of the Lower Passaic River Restoration Project, the sediments of the lower eight miles of the river were identified as a major source of contamination to the rest of the lower river as well as Newark Bay and the New York-New Jersey Harbor Estuary (Appendix D of the FFS, Malcolm Pirnie, Inc., 2007b). Therefore, the FFS (Malcolm Pirnie, Inc., 2007b) was undertaken to evaluate a range of remedial alternatives that might be implemented as an early action to control that source. The Source Control Early Action will address some or all of the contaminated sediments in the lower eight miles of the Passaic River, in order to reduce risks to human health and the environment. The Source Control Early Action, which will be a final action for the sediments in the lower eight miles, is intended to take place in the near term, while the comprehensive 17-mile study is ongoing.

Remediation of the Area of Focus through the Source Control Early Action will reduce the COPC and COPEC concentrations in the surface sediments over the long term to the background concentrations that are introduced to the Lower Passaic River from the Upper

Passaic River. Active remediation is also predicted to reduce the human health risk by 95 to 98 percent (fish versus crab consumption) and the ecological hazard by 78 to 98 percent (species dependent), which meets the RAOs. It is important to note that regardless of the PRG or risk levels that need to be achieved, remediating the Area of Focus achieves clean-up of 2,3,7,8-TCDD, which is responsible for 65 percent of the human health cancer risk, 40 years faster than it would be achieved by MNR alone. The reduction of other COPCs and COPECs is also accelerated by the remediation of the Area of Focus. For these reasons, all active alternatives were developed to remediate the Area of Focus, which encompasses the fine-grained sediments of the lower eight miles in their entirety. It is important to note that a discrete action would be incapable of effecting substantial improvement, as legacy sediments in the entire lower eight miles are actively mixing and acting as an ongoing source of contamination.

Other sources of contamination to the Lower Passaic River, including the Upper Passaic River (located above the Dundee Dam), major tributaries (including Saddle River, Second River, and Third River), CSO/SWOs, and Newark Bay are relatively small contributors of particle-bound contamination when compared with the resuspension of sediment within the Lower Passaic River itself. The USEPA plans to initiate work to identify and characterize contamination entering the Lower Passaic River from the Upper Passaic River (Malcolm Pirnie, Inc., 2007b). Because Newark Bay receives particle-bound contamination from a variety of sources, including the Lower Passaic River, the implementation of the Source Control Early Action will effect a gradual decrease in contaminant concentrations in Newark Bay.

The Source Control Early Action is an effort specifically designed to control contamination sources early. Remediation of the Area of Focus is being conducted prior to the Remedial Investigation/Feasibility Study for entire 17-mile Study Area in order to more quickly reduce a major source of contamination to the Lower Passaic River (*i.e.*, the resuspension of legacy sediments). The EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc., 2007b) identified the resuspension of legacy sediments as a large contributor of contamination concentrations for several COPCs and COPECs; the remediation of legacy sediments would significantly reduce contaminant concentrations in the Lower Passaic River as well as the contaminant loading to Newark Bay and the remainder of the Hudson-Raritan Estuary.

3.2 INVOLVE THE COMMUNITY EARLY AND OFTEN

Efforts to involve local communities along the 17-mile stretch of the Passaic River have been numerous and ongoing. Many of these efforts were presented in the combined Community Involvement Plan for the Lower Passaic River Restoration Project and the Newark Bay Study (Malcolm Pirnie, Inc., 2006a), and others have extended beyond specific elements of this plan.

In 2004, approximately 50 community interviews were conducted with local non-governmental organizations (*e.g.*, Passaic River Coalition, Clean Ocean Action, Ironbound Community Corporation), many of which represented the views of thousands of local and regional individuals in their respective organizations, and individuals across a diversity of interests representing different locations in the region, including Newark, Rutherford, Clifton, Keyport, and Sandy Hook in New Jersey, as well as New York City.

Following the interviews, public information sessions were held in several locations, including a well-advertised and well-attended drop-in session in Rutherford, New Jersey held in January 2005. Two public informational meetings/availability sessions were held in September 2005: one in Rutherford, New Jersey, and one in Newark, New Jersey. An information table was staffed by representatives of the Lower Passaic River Restoration Project partner agencies at the Passaic River Regatta held in October 2005 at the Nereid Boat Club in Rutherford, New Jersey. This event brought together various groups and citizens interested in the revitalization and conservation of the Passaic River.

Representatives from the partner agencies have participated in Passaic River Symposia held at Montclair State University in Montclair, New Jersey in 2004 and 2006, presenting up-to-date work being conducted on the project.

Community involvement efforts have also included municipal outreach. In April 2007, a municipalities workshop for the Lower Passaic River Restoration Project and the Newark Bay Study Area RI/FS was held at the New Jersey Transportation Planning Authority (NJTPA) in Newark, New Jersey. This workshop consisted of an all-day session focusing on project updates, planning, agency coordination, and revitalization of the river (often addressing community-specific concerns). The event attracted approximately 75 attendees, including Alan Steinberg, the USEPA Regional Administrator. Municipalities that participated in the workshop include Bayonne, Bloomfield, Clifton, Elizabeth, Garfield, Harrison, Newark, Nutley, and Rutherford.

A municipalities meeting was held in July 2007 at the NJTPA to discuss cleanup options for the Lower Passaic River. Objectives for the meeting included briefing the municipalities on the Source Control Early Action FFS, obtaining input from the municipalities on the FFS, and continuing discussions on how the municipalities plan to use the river once it has been revitalized. Municipalities that participated in the meeting include Kearny, Harrison, Hudson County, and Newark. During the meeting, representatives of the municipalities expressed a favorable view of incorporating a CDF into the Source Control Early Action, and they expressed a willingness to host that aspect of the remedy in the municipalities.

Municipalities had a direct influence on the development of the remedial alternatives for the FFS. Specifically, the NJDOT prepared a memorandum presenting the State's recommendations for future navigational use of the channel (Appendix F of the FFS; Malcolm Pirnie, Inc., 2007b), which was developed in consideration of municipal master plans.

Throughout these community involvement efforts, partnering with local environmental and civic organizations has been an essential component in informing community members about project meetings and other events. These organizations have posted meeting announcements, press releases, and project information on their websites, which facilitates further outreach to local communities than the partner agencies could have done alone. In addition, partnerships with local organizations foster good faith among community members. Local organizations that have participated include the Association of New Jersey Environmental Commissioners, Bloomfield Third Riverbank Association, Clean Ocean Action, Future City, Green Faith, Hackensack Riverkeeper, Immigration and American Citizenship Organization, Ironbound Community Corporation, Jersey Coast Anglers, Nereid Boat Club, New York/New Jersey Baykeeper, and Passaic River Rowing Association.

The public website for the Lower Passaic River Restoration Project, www.ourPassaic.org, serves as another resource for interested parties to obtain background information, meeting notices, and other project-specific information. The website is maintained by the USEPA and is updated continually as new information becomes available. In addition, the website offers the opportunity for local organizations and individuals to sign up for a ListServ, which delivers project announcements directly to its subscribers via e-mail.

Stakeholder workgroup sessions have been held by USEPA over the past three years and have included presentations and dialog on specific topics, such as modeling; sampling plans, activities, and results; and remedial options development and evaluation. In addition, stakeholder representatives have been welcomed at periodic Project Delivery Team meetings where updates of project progress were provided by the partner agencies and stakeholder input was sought. Advance announcements of these meetings were provided directly to stakeholder representatives and via the public website.

3.3 COORDINATE WITH STATES, LOCAL GOVERNMENTS, TRIBES, AND NATURAL RESOURCE TRUSTEES

The Lower Passaic River Restoration Project is an integrated Study being implemented by the USEPA and several partner agencies as a joint CERCLA-WRDA project. The USACE – New York District serves as the federal WRDA sponsor of the Study, the NJDOT is the non-federal WRDA sponsor, and the NJDEP, NOAA, and USFWS are the Natural Resource Trustees for the Study. Each of these agencies has been involved in the various components of the Study, including the development of planning documents, review of planning and technical documents prior to public release, identification of ARARs, and other aspects of the Study. Each agency attends FFS-specific remedial options workgroup meetings, including comment resolution and consensus meetings. In addition, each agency has had the opportunity to contribute to USEPA decision-making as integral team members throughout the Study.

3.4 DEVELOP AND REFINE A CONCEPTUAL SITE MODEL THAT CONSIDERS SEDIMENT STABILITY

A Draft Geochemical Evaluation (Step 2) (Malcolm Pirnie, Inc., 2006c) and a Conceptual Site Model (Malcolm Pirnie, Inc., 2007a) have been developed for the Study, and sediment stability was considered in the development of both of these documents. The Human Health and Ecological Risk Assessments (Appendix C of the FFS; Malcolm Pirnie, Inc., 2007b), the Pathways Analysis Report (Battelle, 2005), and a Baseline Ecological Risk Assessment workshop held in 2006 [in preparation for the development of the Draft Field Sampling Plan Volume 2 (Malcolm Pirnie, Inc., 2006b)] also contributed to sediment stability discussions presented in the Conceptual Site Model. The initial Conceptual Site Model (Malcolm Pirnie, Inc., 2005a) was based on geochemical and modeling work dating back to 2003 and has been revised (Malcolm Pirnie, Inc., 2007a) using available data and incorporating new data as they were developed. Sediment stability has been investigated in several components of the Study, including the bathymetric analysis and dated sediment core analysis (both discussed in Malcolm Pirnie, Inc., 2006c and Malcolm Pirnie, Inc., 2007a), Sedflume analysis (presented in Borrowman *et al*., 2006), and sediment transport and modeling efforts (Appendix G of the FFS; Malcolm Pirnie, Inc., 2007b).

It is important to note that the consideration of sediment stability (or lack thereof in several locations through the Lower Passaic River) played a major role in prompting the development of the FFS (Malcolm Pirnie, Inc., 2007b) for legacy sediments in the lower 8 miles of the river, which were identified as a major source of contamination to the 17-mile Study Area and to Newark Bay. The FFS was undertaken to evaluate a range of remedial alternatives that might be implemented as an early action to control that major source and more rapidly reduce risks to human health and the environment.

In addition to the work described above, a screening analysis to identify target areas based on sediment stability has been performed. The analysis identified the most erosive reach of the river and subsequently found that remediation of that reach alone was insufficient to achieve the required risk reduction. The FFS also incorporated modeling of the stability of cap materials placed in the erosive setting of the Lower Passaic River (Appendix G of the FFS; Malcolm Pirnie, Inc., 2007b).

3.5 USE AN ITERATIVE APPROACH IN A RISK-BASED FRAMEWORK

An iterative approach has been used throughout the Study with respect to the assessment of available data and the development of new data. Each effort builds on previous efforts, and each component of the Study aims to derive as much information out of new and existing data as possible. Geochemical efforts include the Technical Memorandum: Preliminary Geochemical Evaluation (Malcolm Pirnie, Inc., 2005b), which was further developed into the Draft Geochemical Evaluation (Step 2) (Malcolm Pirnie, Inc., 2006c). Other components of the Study, including the Pathways Analysis Report (Battelle, 2005), the ecological workshop (2006), and the Risk Assessment performed for the FFS

(Appendix C of the FFS; Malcolm Pirnie, Inc., 2007b) have also built upon each other, further refining the characterization of ecological risks and exposure pathways with each new effort.

Sampling efforts have also employed an iterative approach. Bathymetric surveys performed in the fall of 2004 (as well as previous field investigation studies) aided in the development of the intensive geophysical and geotechnical sampling programs in the spring of 2005. Sediment coring and water column investigations conducted from summer 2005 through early 2006 then built upon the geophysical and geotechnical studies, as well as on earlier coring studies conducted by Tierra Solutions, Inc., partner agencies, and others. A kingfisher study performed by USACE – New York District and NJDOT and a sampling plan for biological characterization efforts (both discussed in Malcolm Pirnie, Inc., 2006b; anticipated to be implemented by the Cooperating Parties Group) likewise builds upon previous biological sampling programs conducted by Tierra Solutions, Inc., as well as an Environmental Resource Inventory and Ecological Functional Analysis performed by Earth Tech, Inc. (Malcolm Pirnie, Inc., 2006b). Field investigations in 2004 also provided data for the development of the dredging pilot study and ex-situ sediment stabilization demonstration in late 2005 (Malcolm Pirnie, Inc., 2006d).

In addition to the iterative approach used in field investigation programs and data analysis efforts, the Source Control Early Action FFS builds upon available data to address the ongoing release of legacy sediments through erosion and resuspension, while the full RI/FS for the 17-mile Study Area is ongoing. The development of the FFS represents an iterative approach to the development of remedial options for the Lower Passaic River.

3.6 CAREFULLY EVALUATE THE ASSUMPTIONS AND UNCERTAINTIES ASSOCIATED WITH SITE CHARACTERIZATION DATA AND SITE MODELS

Key documents leading to the development of the FFS (Malcolm Pirnie, Inc., 2007b) included detailed evaluations of assumptions and uncertainties. These evaluations were performed in the Conceptual Site Model (Malcolm Pirnie, Inc., 2007a) and the EMBM (Appendix D of the FFS; Malcolm Pirnie, Inc. 2007b), including an identification of data gaps. The conclusions presented in these documents are framed around key inferences and uncertainties. In addition, the Cap Erosion and Flood Modeling (Appendix G of the FFS; Malcolm Pirnie, Inc., 2007b) includes a detailed discussion of important assumptions and uncertainties in the modeling process.

Although the various data analysis and modeling efforts associated with the Lower Passaic River Restoration Project require that inferences be made and uncertainties be considered, these inferences have been derived from a thorough and comprehensive understanding of the site through the Conceptual Site Model, which was built upon detailed geochemical data evaluations and the assimilation of various data sources. Inferences have been conservative whenever possible and are rationally derived from the CSM. Inferences have been coherent and consistent and, particularly in the EMBM, they work together to provide a more complete understanding of site processes and characteristics.

3.7 SELECT SITE-SPECIFIC, PROJECT-SPECIFIC, AND SEDIMENT-SPECIFIC RISK MANAGEMENT APPROACHES THAT WILL ACHIEVE RISK-BASED GOALS

The selection of site-specific, project-specific, and sediment-specific risk management approaches is reflected in the development of the active remedial alternatives presented in the FFS (Malcolm Pirnie, Inc., 2007b). The alternatives were developed without a presumption of a specific remedy. Based on the Risk Assessment performed for the FFS, three basic approaches were considered: natural recovery processes; remedial action in a small area of the Lower Passaic River; and remedial action in the entire eight-mile stretch of the Lower Passaic River. It was necessary to address the entire eight-mile stretch in order to achieve the required risk reduction within a reasonably foreseeable time frame. The active remedial alternatives presented in the FFS were developed to address contamination in this eight-mile stretch.

The elements used to construct the remedy were developed in consideration of site-specific, project-specific, and sediment-specific aspects. For example, the configuration of the navigation channel, and the requisite amount of sediment removal to both construct the channel and subsequently cap the area to aid in achievement of risk reduction objectives, was developed in consideration of the site-specific navigation needs of the municipalities lining the banks of the Lower Passaic. The understanding of the interplay between deposition and discharges, which led to thick sequences of contaminated fine-grained sediment built up over native, less-contaminated sands, was used to select sediment-specific approaches for covering the dredged surface (*i.e.*, engineered capping was selected to cover areas in which fine-grained sediment remained after dredging, while sand backfill was chosen for areas in which all fine-grained sediment was removed and a sand surface remained). Finally, the input of a diverse ground of project-specific stakeholders was utilized at various points in the development of the remedy.

3.8 ENSURE THAT SEDIMENT CLEANUP LEVELS ARE CLEARLY TIED TO RISK MANAGEMENT GOALS

Cleanup levels for the lower eight miles of the Passaic River were developed based on an evaluation of ARARs, RBCs, and background concentrations and the subsequent selection of PRGs. Background contaminant contributions to Study Area were considered to adequately understand contaminant sources and establish realistic risk reduction goals. Background concentrations from Newark Bay and the Upper Passaic River (located above Dundee Dam) were considered, as well as harborwide background concentrations. The background concentrations derived from recent sediment data from the Upper Passaic River were found to be above the risk-based thresholds. Since the Superfund program, generally, does not clean up to concentrations below natural or anthropogenic background levels (USEPA, 2002c), background concentrations were selected as PRGs. Active remediation of the Area of Focus through Source Control Early Action is predicted to reduce the human health risk by 95 to 98 percent (fish versus crab consumption) and the ecological hazard by 78 to 98 percent (species dependent), which meets the RAOs.

The background levels for many of the contaminants pose unacceptable risks, in part resulting from continuing contributions from upstream sources. Thus, while the Source Control Early Action addresses the contaminated sediments of the lower eight miles of the Passaic River, a separate source control action will need to be implemented above Dundee Dam to identify and reduce or eliminate those background sources. Such a separate action might include identifying facilities above the dam with on-going contributions to the Upper Passaic River, or conducting a track-down program where samplers are placed further and further upstream until contaminants are tracked back to specific industrial or municipal sources. Such sources would then be controlled through federal or State of New Jersey regulatory programs. The USEPA plans to initiate work to identify and characterize contamination entering the Lower Passaic River from the Upper Passaic River (Malcolm Pirnie, Inc., 2007b).

The use of background concentrations rather than purely risk-based goals considers the degree of recontamination expected over time after the Source Control Early Action has been implemented. The use of background concentrations also affects the amount of time required for MNR to succeed after implementation of the Source Control Early Action, rather than the areal coverage of capping and depth of dredging required for the remedial action itself. However, it important to note that preliminary remediation goals would be achieved in a shorter time frame if the fine-grained sediments in the 11 miles of the

Lower Passaic River above the Area of Focus were targeted as part of the Source Control Early Action.

3.9 MAXIMIZE THE EFFECTIVENESS OF INSTITUTIONAL CONTROLS AND RECOGNIZE THEIR LIMITATIONS

Institutional controls to be implemented after the Source Control Early Action focus on use restrictions on the waterway. Existing fish consumption advisories will remain in effect and will be gradually relaxed according to risk thresholds as sediment and fish tissue concentrations improve over the long-term. (See Section 2.7.2 "Preliminary Remediation Goals" for PRGs for contaminants that tend to bioaccumulate in fish, such as dioxin, PCBs, and mercury.) Fish consumption advisories have definite limitations, however. Although fish consumption advisories are currently in place for the Lower Passaic River, public surveys have confirmed that certain communities along the river consume unsafe amounts of fish from the river despite the advisories. As an institutional control, the issuance of fish consumption advisories relies on consistent implementation by individual community members.

In addition to fish consumption advisories, waterway use restrictions will include restrictions on dredging to create additional berths predecisional -deliberative predecisional - deliberative Prior to implementation, it is recommended that the USEPA and NJDOT conduct a focused effort to identify any berth areas needed by the communities and/or industries along the Lower Passaic River. Dredging to create these berth areas can then be incorporated into the Source Control Early Action. predecisional -deliberative predecisiona l - there will likely be stringent restrictions on dredging portions of the river that have been capped because of the potential for enhanced recontamination of the capped surface over a large area due to resuspension of contaminated sediments from below the cap and subsequent tidal mixing. Therefore, if a proposed berth area is identified in a capped area, the dredging to create this berth area would need to be conducted such that resuspension of contaminated sediments in the berth area is minimized or avoided. (This may be accomplished by completely surrounding the area to be dredged with sheet pile; however, the installation of sheet pile may create secondary effects such as the restriction of river flow and associated impacts to river flooding, as well as increased cap scour adjacent to the area to be dredged. An evaluation of these secondary effects would be required prior to dredging.) In addition, replacement of the engineered cap in the new berth area would be required. predecisional -deliberative

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Like other institutional controls, placing restrictions on dredging portions of the river that have been capped has its limitations. Controls on post-remediation dredging to minimize resuspension of contaminated sediments still incorporate some risk of recontamination of adjacent areas; this risk cannot be completely eliminated. The most effective method of reducing this risk (despite the presence of institutional controls after remediation) is to incorporate berth area dredging into the Source Control Early Action and avoid post-remediation dredging to the greatest extent possible.

3.10 DESIGN REMEDIES TO MINIMIZE SHORT-TERM RISKS WHILE ACHIEVING LONG-TERM PROTECTION

As part of the FFS, the short-term risks associated with each of the active remedial alternatives were evaluated and compared. (See Section 2.9.5 "Short-Term Effectiveness" for a summary of these evaluations.) predecisional -deliberative

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option to dredge contaminated sediments was not rejected simply because dredging will cause some resuspension of particle-bound contamination. Since sediment resuspension is currently ongoing, and the ultimate goal of the Source Control Early Action is to drastically reduce erosion and resuspension of legacy sediments as a source of contamination to the river, the additional potential resuspension associated with dredging operations was not a deciding factor when evaluating active remedial alternatives involving dredging.

All aspects of remedy design and implementation will be developed in consideration of Health and Safety Plans generated to provide protection and reduce risks for workers and the surrounding community. Work areas in the river would be isolated (access-restricted) for safety reasons. In addition, selected aspects of the remedy design which may be incorporated to reduce short-term risks include:

- Construction and Operation of a Support Area: The site for the support area is assumed to have riverfront access, and access to these areas would be restricted to authorized personnel. An ambient air monitoring program could be implemented where required to provide protection for the surrounding community. As the land use near the Lower Passaic River is primarily industrial, minimal additional environmental impact is likely to arise from the construction of the support area.

- Dredging: Dredging operations (including dredging and transportation of dredged material) will inevitably involve short-term impacts associated with resuspension of sediment. However, installation of structures to isolate areas of dredging would also likely result in some degree of resuspension, and would result in a longer timeframe necessary to achieve remedial action objectives. For these reasons, the utilization of best management practices and specialized technology is more likely to achieve a more favorable balance between short-term impact and long-term risk reduction than dredging using containment structures.

- Capping: Capping operations may be less disruptive of local communities than dredging (USEPA, 2005), and would result in less potential for noise disturbances and air pollution than dredging operations. Environmental impacts during capping would be mitigated by using cap placement techniques that avoid resuspension to the extent practicable, but a temporary loss of habitat would be an inevitable impact associated with the placement of cap material.

- CDF Construction and Operation: Activities associated with capping and CDF construction would also result in a temporary loss of habitat for aquatic and benthic organisms. However, the use of a CDF for dredged material storage and disposal would likely result in a shorter timeframe for achievement of RAOs, as the potential for delay and issues with throughput and capacity associated with other transport and disposal methods would be eliminated.

- Thermal Treatment: Thermal destruction was included in the remedy development because it is one of the only technologies proven as effective in treating the organic COPCs and COPECs (*i.e.*, PCDD/F, PCB, and PAH) detected in the sediment of the Area of Focus. Air emissions generated by a thermal destruction facility would be strictly monitored and controlled to ensure protection of the surrounding community and air quality.

3.11 MONITOR DURING AND AFTER SEDIMENT REMEDIATION TO ASSESS AND DOCUMENT REMEDY EFFECTIVENESS

Monitoring is incorporated into the Source Control Early Action and includes monitoring during implementation of the remedy and after implementation has been completed. Both the effort and the estimated costs for monitoring have been evaluated for the remedy and are presented in the FFS (Malcolm Pirnie, Inc., 2007b). Monitoring includes chemical analyses to characterize sediments and the water column, as well as biological tissue. Table 3-1 summarizes the annual monitoring activities that are incorporated into the Source Control Early Action.

Table 3-1: predecisional - deliberative Annual Monitoring Program

Monitoring Type	Monitoring Frequency	Monitoring Parameters
Surface Sediment Sampling	400 samples per year; 5 samples taken at transects of 0.1 river mile	• Geotechnical parameters [grain size, percent moisture, total organic carbon (TOC)] • Target Analyte List metals • Cyanide • Dioxins
Water Column Sampling	35 samples per year; 2 samples taken for 2 tidal cycles per river mile	• Total suspended solids • TOC
Groundwater Sampling	144 samples per year; 12 wells sampled per month	• Parameters to be determined
Biological Monitoring	One monitoring program per year	• Habitat delineation • Terrestrial vegetation • Avian community • Aquatic community • Aquatic vegetation (SAV) • Fish community • Benthic invertebrates • Biological tissue-residual • Toxicity testing

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4.0 ACRONYMS

2,3,7,8-TCDD	2,3,7,8-Tetrachlorodibenzodioxin
AOC	Administrative Order of Consent
ARAR	Applicable or Relevant and Appropriate Requirement
BDA	Brownfield Development Area
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMB	Chemical Mass Balance
COPC	Contaminant of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
CSM	Conceptual Site Model
CSO	Combined Sewer Overflow
CSTAG	Contaminated Sediment Technical Advisory Group
CWA	Clean Water Act
cy	cubic yard
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DDx	Sum of DDD, DDE, and DDT isomers
DMM	Dredged Material Management
EMBM	Empirical Mass Balance Model
ER-L	Effects Range-Low
FFS	Focused Feasibility Study
HMW	High Molecular Weight
H:V	Horizontal:Vertical
LMW	Low Molecular Weight

LWA	Length-Weighted Average
mg/kg	milligram per kilogram
MLW	Mean Low Water
MNR	Monitored Natural Recovery
ND	Not Determined
ng/g	nanogram per gram
ng/kg	nanogram per kilogram
NHPA	National Historic Preservation Act
N.J.A.C.	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJPDES	New Jersey Pollutant Discharge Elimination System
N.J.S.A.	New Jersey Statues Annotated
NJTPA	New Jersey Transportation Planning Authority
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priority List
NRRB	National Remedy Review Board
O&M	Operations & Maintenance
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PATH	Port Authority Trans Hudson
PCB	Polychlorinated Biphenyl
PCDD/F	Polychlorinated Dibenzodioxins/Furans
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
PRSA	Passaic River Study Area
RAO	Remedial Action Objective
RBC	Risk-Based Concentration

RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RM	River Mile
ROD	Record of Decision
SPMD	Semi-permeable Membrane Device
SWO	Stormwater Outfall
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalent Quotient
TOC	Total Organic Carbon
TSCA	Toxic Substances Control Act
TSI	Tierra Solutions, Inc.
μg/kg	microgram per kilogram
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WRDA	Water Resources Development Act

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